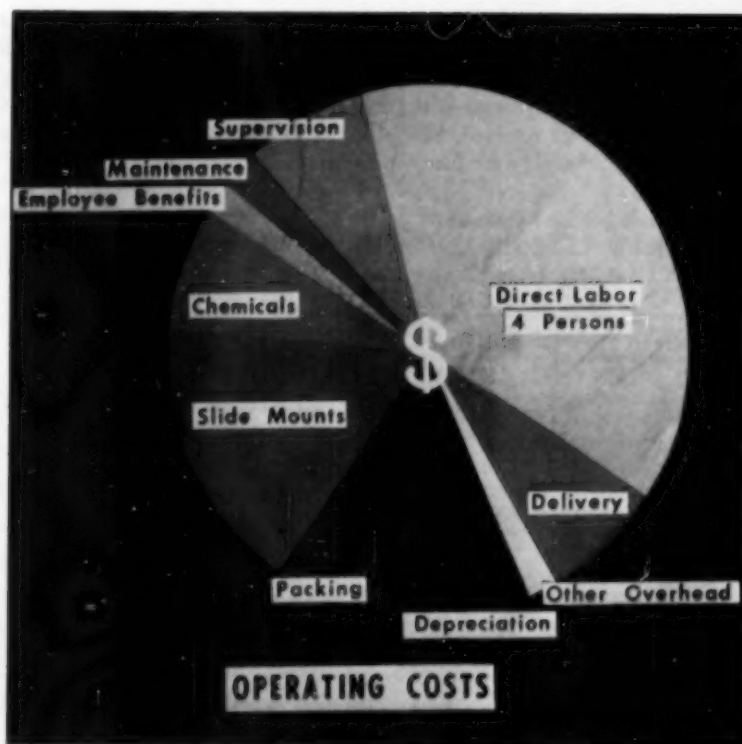




PHOTOGRAPHIC SCIENCE and TECHNIQUE

AUGUST 1956

Series II, Vol. 3, Number 3



THE FINANCIAL ASPECTS OF COLOR FINISHING
BY DONALD M. KLADSTRUP

TECHNICAL QUARTERLY
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SOCIETY OF AMERICA

YOU CAN'T PLEASE EVERYONE

Tastes differ. So do interests and expectations and the capacity for enjoyment. Such commonplace observations are as familiar as the title for this month's editorial.

The Color Processing Conference was designed to interest, to inform, and, perhaps, to please the photofinishing fraternity. Color finishers or prospective color finishers who attended the event in Rochester, New York May 25 and 26 were the audience for whom the entire program had been designed.

The Technical Division of the PSA succeeded pretty well in this unselfish aim to organize and produce a program for a separate group. The result appears to have been more successful than former attempts by the Technical Division to produce programs for the benefit and enjoyment of pictorial photographers within the Society.

The unexpectedly high registration at the Color Processing Conference testified to the broad appeal of the advance program announcement. Attendance at technical papers sessions by more than 75% of the people registered was an unusual indication of serious interest in the proceedings. The rapt attention with which large audiences sat through the papers sessions, and the near absence of coming and going by tourists with their minds elsewhere, was a tribute to the quality of the papers and to the talents of the speakers.

Howard Colton, the General Chairman, and members of his Committee received many compliments on the organization and management of the affair. A few adverse comments were received, too, along with advice concerning the arranging for future conferences on the same subject.

Some people believed that the papers, in general, were not sufficiently technical. These comments did not come, of course, from the photofinishers and the pro-

spective color finishers for whom the conference had been organized. They came for the most part from individuals within the photographic manufacturing industry who had misconceptions concerning the purpose of the Conference.

It may be that Technical Division activities have so often in the past been associated with "long-haired" technical and research papers on photographic subjects that nothing else is expected. If Technical Division programs had got into that rut, they are out of it now. It is, perhaps, a tribute to the versatility of the Division officers that they were able to conceive and to carry out so successfully a meeting for a specialized group of color finishers on a subject of restricted interest such as color finishing.

Perhaps the most frequent complaint had to do with the subject of discussion and questions from the floor. At photographic technical meetings, questions from the floor follow a tradition that has been on the wane for many years. The Program Committee decided that the Color Processing Conference should ignore that tradition for a very good reason. There simply wasn't time to indulge the few individuals in any audience who want to question the speaker before a crowd instead of in the corridor outside or by correspondence later.

The two-day Conference had been designed as a concentrated event for busy people in which a maximum of information was packed into a minimum of time. The Color Processing Conference dealt with a brand new audience, a brand new theme, and a stream-lined procedure for conducting technical papers sessions.

Restricting the topics at the Color Clinic to questions in writing only was an item in the original plans for the Color Processing Conference. The aim was to improve

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IN THIS ISSUE

THE FIRST COLOR PROCESSING CONFERENCE	HOWARD C. COLTON	85
FINANCIAL ASPECTS OF COLOR FINISHING	D. M. Kladstrup	86
COLOR TRANSPARENCIES—VIEWING CONDITIONS CONTROL THEIR SUCCESS	BETTY HAITHWAITE	91
TRANSPARENCY DUPLICATION MATERIALS AND PROCEDURES	IRA B. CURRENT	93
TEN YEARS EXPERIENCE IN COLOR PHOTOFINISHING	LEO S. PAVELLE AND LLOYD E. VARDEN	97
THE SOLUBILITY OF SILVER BROMIDE AND SILVER CHLORIDE IN AQUEOUS SOLVENTS	M. A. HILL, C. W. ZUEHLKE, AND A. E. BALLARD	101
PSA TECHNICAL PAPER AWARD FOR 1955	J. I. CHABTREE	106
AN ALUM-ORGANIC WASH TANK SLUDGE	K. R. HUGHES, R. W. HENN, AND J. I. CHABTREE	107
PROCESSING REQUIREMENTS OF ANSCOCHROME TYPE PRINTON FILM	CARL E. JOHNSON	113
AMERICAN STANDARDS FOR COLOR FINISHERS	R. J. WILKINSON	119

NOTE: Remaining papers from the Color Processing Conference held in May 1956 in Rochester, New York will appear in the November issue.

the dignity of the proceedings. When more than 500 people assembled for the Clinic, it became apparent to everyone that acoustics and communication problems made any other procedure impracticable. More important, however, was the realization that discussion from the floor would have been manifestly unfair to an audience of that size, especially if the questions were not genuinely in quest of information.

The tradition of questioning speakers from the floor and the conduct of panel discussions had their origin in and they fit the needs of relatively small groups, such as the symposium or colloquium. But even the members of small audiences have grown tired of some of the pests who infest such meetings.

There is, of course, the mere show-off, the grown-up "teacher's pet" who is compelled by some vestige of adolescent yearning for recognition to stand up before an audience and ask a question simply as an excuse to be seen.

Even inexperienced speakers recognize and dread the clever individual who schemes and plans—sometimes for weeks before the meeting—to formulate a question which will embarrass the speaker before the audience and consequently reflect glory on the questioner.

One of the lesser nuisances is the dozer who failed to pay attention, or even falls asleep when the lights go out for the slide showing, and wants the speaker to fill him in on parts he missed.

Another pest is the expert in some other field who wants to argue with the speaker about corollaries with the subject and cite examples of his own work which had no bearing on the speaker's thesis.

A near relative is the expert who sits in an audience of novices and listens to a paper artfully designed for their level of knowledge, comprehension and interest, then rises to ask highly technical questions of the speaker in order to show how far advanced he is over the rest of the audience.

In the case of panel discussions, similar nuisances may be found in the audience. The practice of using written questions allows the Moderator to spare the audience from digressions away from the subject of the meetings. It improves the quality of the questions asked by requiring, in the mere act of writing, a more thoughtful and precise choice of words to phrase the question. The use of written questions can save the panel members from witless requests for predictions and the solicitation of personal opinions in the place of factual information.

Many other types of questioners are known to speakers and the above may serve to call them to mind. There is no doubt that they are, to one another at least, interesting performers. Very likely their personalities and their antics amuse many people in the audience. Some of the more accomplished speaker-hecklers may even develop a following, but the art is going out of fashion. There

seems to be emerging a growing awareness that the questions contribute little to the information which the audience derives from a paper presentation. The questioner who arises to argue a point with the speaker or to call attention to a case of his own is no longer welcomed by serious minded, information seeking people in the audience.

P. A.

INFORMATION ON PHOTOGRAPHY

Sources of information about still photography, published in the United States in the English language, have been compiled by the Business & Defense Services Administration of the U.S. Department of Commerce. Ask for BSB No 128 (July 1955).

This six page bulletin includes references relating to photographic equipment such as cameras, projectors, lenses, and enlargers; and developing and printing apparatus such as microfilm, blueprint, photoreproduction equipment, sensitized papers, films, and plates. Sources are classified as (1) U.S. Government Publications, (2) Nongovernment publications, and (3) Trade Associations. Some 22 organizations in the latter category include the Photographic Society of America.

RAPID AERIAL CAMERA SHUTTER

To cope with the enormous velocities of guided missiles and other supersonic defense developments, the Fairchild Camera and Instrument Corporation has produced a radically new between-the-lens aerial camera shutter—with the help of the Titanium Metals Corporation of America and the Hamilton Watch Company, who have supplied this information.

The new shutter, called the Rapidyne, has a number of unique features. It is capable of speeds up to one five-thousandth of a second. This extraordinary speed is accomplished through a revolutionary design concept. Where ordinary between-the-lens shutters have one set of leaves which open, stop, and shut

The Rapidyne is of large diameter, up to three-and-one half inches, and consequently, a large amount of physical force is exerted on its leaves. Heretofore shutters of this size, which were low-speed, used heavy, spring-tempered steel leaves. Such leaves, it was early discovered, were unequal to the high impact and velocity of the Rapidyne.

Many metals and alloys were tested in search of one with the necessary characteristics of lightness, rigidity, corrosion-resistance, strength, and susceptibility to precision fabrication. For a time, aluminum seemed to supply the answer, but stresses of the Rapidyne in operation caused it to fatigue rapidly, with resultant cracking, or "scissoring." This phenomenon occurs when the leaves, closely juxtaposed, buckle slightly and touch each other in transit, slowing or jamming the shutter, and scoring and wearing the leaves.

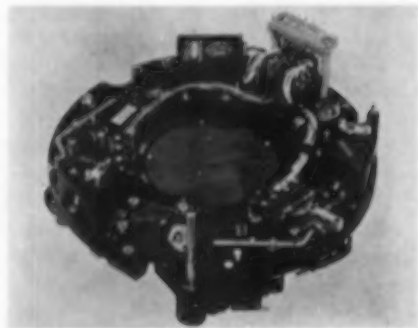
Continued testing revealed, finally, that commercially-pure titanium, supplied by the Titanium Metals Corporation of America had the requisite strength and lightness characteristics and could be worked to the necessary precise dimensions—in the laboratory. Precision production was something else, as Fairchild soon discovered.

Fairchild representatives tried commercial metal fabricators all over the country. Many of them had rolling equipment which could bring titanium down very thin but none was capable of meeting the specifications for the leaves of the Rapidyne—.0022 of an inch thick with tolerances of plus or minus .0001 of an inch. An additional drawback was that the commercial fabricators deal with tonnage, while the minute dimensions of the Rapidyne parts reduced the whole operation to "ounce-age."

The Hamilton Watch Company's Allied Products Division, in its main plant in Lancaster, Pa., offers specialized services in high precision metal working in relatively small amounts. These services are an off-shoot of Hamilton's metallurgical research in watchmaking and its extensive experience in precision defense work.

The processing of titanium to Fairchild's specifications, while hardly to be considered routine, was well within Hamilton's capabilities, since one of the features of its precision manufacturing facilities is a special Sendzimir cold rolling mill which will work metal down to sheet of one ten-thousandth of an inch in thickness, with tolerances of plus or minus one one-hundred-thousandth of an inch, with a very smooth finish.

With the titanium fabrication problem solved, the Rapidyne shutter went into production and is now employed in most Fairchild cameras. Some of these, particularly those used by the Air Force in guided and ballistic missile research and development, have new and improved control systems made possible by the Rapidyne. Among the Fairchild models using the Rapidyne are the "K-47" night camera system, the "T-11" precision mapping camera, the "KB-5" gun camera designed for recording aerial combat by supersonic jets, and the Fairchild industrial motion analysis camera.



again, the Rapidyne has two sets of leaves. One set opens, and, as it reaches the end of its arc, activates a triggered second set, already open, which snaps closed. This obviates the usual dead stop and reversal of motion—an important factor when time is being measured in thousandths of a second.

Many problems were encountered in the one-year period between the completion of the design of the Rapidyne shutter and the first deliveries to the Air Force. The finding of a suitable metal, and its fabrication into shutter leaves, were the most nettling of these.

THE FIRST COLOR PROCESSING CONFERENCE

Howard C. Colton*

SOME seven hundred people interested professionally or commercially in the processing of color photographs attended the first Color Processing Conference. It was held May 25th and 26th in Rochester, New York, under the sponsorship of the Technical Division of the Photographic Society of America. The extraordinary success of the event and the many comments which have been made concerning future meetings of the same type constitute both a source of pride and a challenge to the Technical Division and the Society. It may seem in order, therefore, to discuss the background history of the Conference and report briefly on its accomplishments.

During the National Convention of the PSA in Boston, October 1955, the Executive Committee of the Technical Division held a meeting at which it was decided that the Technical Division meeting in 1956 would be separate from the PSA National Convention in Denver, Colorado. During the course of the discussion about such a meeting, Dr. Clyde Carlton suggested that a most timely topic for a conference early in 1956 would be the subject of color processing. This seemed to be a worthwhile suggestion and the Committee approved such a program to be held after the SPE Convention in early May and before the traditional start of the photofinishing season on Memorial Day, which would keep interested individuals from attending. Herbert A. MacDonough, Chairman of the Technical Division, appointed Howard Colton as General Chairman of the event with the assignment to organize a committee to plan and conduct the meeting.

After some preliminary discussions in the late fall, it was decided that Rochester would be a suitable site and May 25 and 26 were selected as the most appropriate days in view of available facilities for the meeting. The name "Color Processing Conference" was agreed upon.

The Committee consisted of Mr. Charles Kinsley as Assistant Chairman, who also took charge of projection facilities. The technical papers program was assigned to Paul Arnold, with the assistance of Hugh Scheffy. The Conference Treasurer and Registration Chairman was Gard Mason. Bill Shoemaker of the Rochester Institute of Technology was appointed to organize the luncheon and banquet meetings that were proposed as an integral part of the Conference, and Clyde Carlton arranged for the banquet speaker and entertainment. Jim Griffin was in charge of the housing arrangements and Dick Edgerton, the Division Secretary-Treasurer, took the responsibility of organizing a reception committee.

It was proposed that two field trips be part of the program and this was organized by Art Neumer. The publicity for the meeting was handled by the Publicity Chairman for the Technical Division, Gene Richner. Bill Crain, in charge of the print exhibit for the Technical

Division, arranged to have the 1956 show as part of the program, and the Trade Exhibit was planned and organized by Tom Ward. The Rochester Technical Section was given charge of the printing of the program, under the supervision of George Eaton and Bob Barrows.

Early in the discussions for this Conference, it was decided to hold the whole affair in a single location, and the Seneca Hotel was selected because of its excellent facilities for this purpose. An attendance of approximately 200 to 250 was expected and plans were made on that basis. A blanket fee was charged to cover registration, field trips, banquet and luncheon, etc., and the various committees undertook to have everything in readiness for the May meeting.

By early spring, some publicity releases were available to the photographic field and members of the Committee soon became aware that they might have a "lion by the tail." Before a program of events could be announced, registrations began to pour in to Gard Mason. By Conference time, a program of 19 papers had been prepared, covering a wide variety of topics of interest to color technicians, photofinishing and color processing laboratory personnel. The papers were concentrated in three half-day sessions, the other half day being devoted to field trips either to see Kodacolor print production at Kodak Park or the Photofinishing Sales Laboratory at the Kodak Hawk-Eye Works.

The program opened Friday morning, May 25, with a large audience ready for the first paper promptly at 9:00 a.m. All paper sessions were very well attended, with the audience ranging from 400 to 500 people for each of the papers presented. The topics seem to have been wisely chosen as there was almost no traffic in and out of the auditorium during the concentrated paper sessions. At the Friday luncheon, the Conference members were welcomed by Joe Allendorf of Eastman Kodak Company and after lunch the group split up to go on their chosen field trip. Friday evening there was a Color Clinic, with a panel of seven experts, directed by Mr. Leslie Gaut of Fas Foto, Inc. of Cincinnati, Ohio. The panel members battled practically 1000 in taking care of questions regarding color materials or processing that were raised by Conference members. This program also was very well attended and apparently satisfied the needs of many of those in attendance.

Both Friday and Saturday the Trade Exhibit was open on the mezzanine floor of the hotel. The exhibits of sixteen manufacturers were well patronized by those in attendance. The various booths showed both equipment and sensitized materials of interest to the color processor. Many favorable comments were received from the exhibitors afterwards about the interest expressed in their products and services.

The Conference reopened Saturday morning, with papers lasting until 5:00 p.m., with a brief interlude for lunch. Saturday evening the meeting was concluded with a banquet at which Valentino Sarra, eminent color

* General Chairman, Color Processing Conference sponsored by the Technical Division of the PSA in Rochester, New York, May 25 and 26, 1956.

photographer of New York City, gave an illustrated talk on his experiences in making personal color pictures during a vacation trip in Europe. Entertainment was provided by the Note Crackers, a Rochester barbershop quartet group of national fame. John Crabtree of Kodak Research Laboratories presented the PSA Technical Paper Award for 1955 to Dr. T. Howard James for his paper, "Dependence of the Rate of Development of Surface Latent Image on the Temperature of the Developer," Mr. John Brostrup of the Armed Forces Institute of Pathology received an Honorable Mention for his paper "Simultaneous Multiple Dye Transfer Color Printing." Division Chairman, Herb MacDonough, acted as emcee for the evening's festivities.

In looking back at the Conference, it would seem as though the most outstanding characteristic was the widespread need and desire of people in the color proc-

essing field for information of the type that was presented by Conference speakers. It is rather startling to note that almost all those who registered for the meeting did so before the Conference opened and a good percentage before they knew anything about the program, beyond its general concern with color processing. The total registration figure was 700 and registrants came from all parts of the United States, and from as far away as Alaska, specifically for this meeting.

The Conference Committee members who worked out the details of the meeting, especially the very efficient handling by Gard Mason of the unexpectedly large number of registrants and the well-chosen program papers gathered together by Paul Arnold and Hugh Scheffy, deserve the thanks of the Technical Division. Everyone carried out his part and made this first Color Processing Conference a remarkable success.

THE FINANCIAL ASPECTS OF COLOR FINISHING

D. M. Kladstrup*

ABSTRACT

The financial factors to be considered by the prospective color finisher are analyzed for color finishing in general and for processing of reversal film and paper in particular. Hypothetical cases are presented for the guidance of the photofinisher to help him organize his financial planning in a field where there are few statistics and little reported experience for guidance.

PHOTOFINISHERS have shown their serious interest in color by the type of questions they have been asking about Kodak processes. These questions are not confined to technical points—they have dealt with the financial, or "bread-and-butter" side, too.

The technical questions have been answered fairly well, through publications, demonstrations, and the Company's technical representatives. The financial questions, however, are more difficult, for they have dealt with such topics as: HOW MUCH CAPITAL WILL I NEED TO GO INTO BUSINESS? and WILL COLOR FINISHING BE PROFITABLE FOR ME?

These are extremely important questions. Color finishing is a comparatively new industry, and some of the color processes are completely new. In some cases the initial investment is necessarily large, and an ill-advised decision to enter the color processing field could lose the photofinisher many dollars. At the same time, properly made plans might well point the way to some very satisfying profits.

It is obvious that there is no single set of answers to these questions. If there were, anyone who wanted to go into business would merely open a little reference book, determine the exact amount of capital needed, invest that capital, and then sit back and watch the pre-computed profits roll in.

If he should become bored, he could sell out, complete with guaranteed profits. Then, with the book to guide him again, he could reinvest in some other pleasantly profitable line.

What a wonderful, preposterous little book.

We all know that business is not that simple. The conditions under which two businesses are carried on are never the same. Initial capital requirements will vary, depending on the volume of business to be handled, the equipment selected to do the work, whether premises are to be rented or owned, and the amount of working capital needed to meet the costs of doing business.

Income will vary with the type of market served, the selling effort exerted, competition, and prices. Costs will vary with the prices of labor and materials, the type of equipment, production volume, seasonal and day-to-day variations in production requirements, and general operating efficiency.

Even with favorable selling prices and a highly efficient operation, profit still is not assured. Many expenses are fixed—such as rent, depreciation, office work, maintenance, insurance, certain utilities, and the like. The amount of business transacted must be more than enough to cover both these costs and labor and materials as well, in order for the business to be profitable. *What, then, can the prospective color finisher do to make sure that going into color finishing will be a wise move for him?*

The following are the basic steps that should be taken as part of a prospective color finisher's financial planning:

1. First, *estimate processing volume*. This should be done before anything else, because without this infor-

* Eastman Kodak Company, Rochester 4, New York. Presented at the Color Processing Conference sponsored by the Technical Division of the PSA in Rochester, New York 25 May 1956. Received 7 June 1956. By special arrangement this paper is being published simultaneously in Photo Developments for August 1956.



Fig. 1. Kodak Slide Mounting Press (left), for 2 x 2-inch slides, Model 1, and Kodak 35mm Film Cutter, Model A (right), figured in equipment costs for Ektachrome film processing.

mation, it is impossible to estimate sales income, equipment requirements, or operating costs.

Volume estimates should be made in terms of rolls and prints. If sales will be made both to dealers and directly to consumers, the estimate should be broken down between these two categories. Population trends in the community should be considered, as well as any factors that may cause buying habits to change.

2. Next, *determine the physical facilities required*. This means plant, plant location, and equipment. In many cases it will be possible to carry on color finishing in the same location as an already existing black-and-white plant, with only minor adjustments in plant layout. In other instances it may be necessary to obtain an entirely new location. Equipment requirements should be listed in detail, and a careful check made to make sure the equipment can be operated properly in the plant space available.

3. The third step is to *estimate sales income*. Here the finisher will have to decide upon list selling prices, and the discount he will offer to dealers. Applying these figures to the estimated volume will give estimated sales income.

4. Next, *estimate operating costs*. This is perhaps the most difficult part of the estimating job, and the finisher will probably want the help of his accountant. Such information as machine capacity, operator requirements, efficient plant layouts, materials usage, prices, etc., should be checked carefully.

5. The fifth step is to *prepare a statement of estimated profit and loss*. At this point the photofinisher will have a fairly good idea of whether color finishing will be profitable for him.

6. It is often helpful to *compute the break-even point*. This is another way of measuring profitability. It requires the same estimates of income and expense that are used in making up a profit and loss statement, but differs in that it distinguishes between costs which increase or decrease with sales volume and those which are not affected by sales.

The break-even point calculation provides at least two important types of information: a. The *minimum volume* of business needed during the year to break even;

and b. A basic analysis of expense and income that can be used as an important expense control tool.

7. The next step is to *estimate capital requirements*. In addition to plant location and equipment, a provision must be made for working capital. Unless production volume will be subject to severe seasonal variations, the experience of many black-and-white photofinishers indicates that the equivalent of *three months of normal operating costs* is a reasonably safe yardstick for measuring initial working capital needs.

8. The final step is to *make sure the necessary capital is available*. An initial capital plan is important enough so that it should be drawn up in writing, listing both capital needs and the sources from which the capital will be obtained. Diversion of funds needed in black-and-white photofinishing should be avoided, for this would only mean two capital problems instead of one.

Those are the steps that should be included in any financial plan. In the following, they will be applied to a couple of hypothetical cases; first, a problem involving Ektachrome film developing, and then a setup for the manufacture of prints on Kodak Color Print Material, Type R. In both cases it is assumed that black-and-white photofinishing is already being done in the same plant and that the premises are rented.

Time will not be taken to go through all the steps needed for complete analysis. Equipment lists and some estimated operating costs will be examined and the basis for them as well as the capital requirements.

Ektachrome Film Developing

For Hypothetical Case Number 1, Ektachrome developing, an estimated annual processing volume of 50,000 rolls is assumed. If the plant operates 5 days per week, daily production will average roughly 200 rolls. This is a good volume for the Kodak Rack and Tank Color Processor, Model 10-E, and since this machine has a capacity of up to 500 rolls during an 8-hour day, there is also room for expansion. This then becomes the first item on the equipment list, with a price of \$4,850.

Also needed in this example are extra film racks for use with the processor, a drying cabinet, two 35mm Film Cutters (See Figure 1), two 2 x 2-inch Slide Mounting Presses, chemical mixing equipment, plumbing and tem-

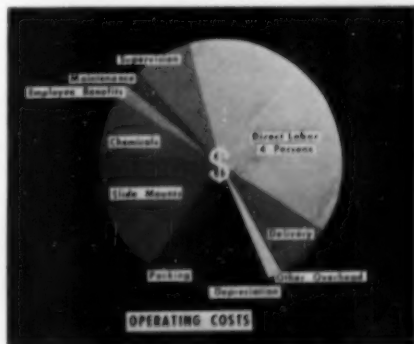


Fig. 2. Apportionment of operating costs for hypothetical Ektachrome film processing laboratory with capacity for 50,000 rolls of 35mm film annually.

Table I

ESTIMATED EQUIPMENT REQUIREMENTS FOR ANNUAL VOLUME OF 50,000 ROLLS 35mm EKTACHROME FILM DEVELOPING

Item	Approximate Cost
Kodak Rack & Tank Color Processor, Model 10E	\$ 4,850
15 Extra Kodak Film Racks for Model 10E Processor	1,275
Drying Cabinet	300
2 Kodak 35mm Film Cutters, Model A	140
2 Kodak 2 X 2-inch Slide Mounting Presses, Model 1	640
Chemical Mixing:	
Mixer	125
6 25-gal. Stainless Steel Tanks at \$70	420
1 25-gal. Brass Tank	185
Plumbing	320
Plumbing and Temperature Control:	
5-ton Water Chiller	1,085
Heating Unit	575
Plumbing	300
Air Conditioning	400
Total	\$10,615
Allowance for Contingencies, 10%	1,065
Allowance for Space Alteration	820
Total Estimated Equipment Costs	\$12,500

perature control, and air conditioning. As a matter of precaution, an extra 10% has been allowed for contingencies, plus a amount for space alteration.

The total estimated equipment requirement, as shown in Table I, comes to a round figure of \$12,500.

In the matter of operating costs, of course, the most important item is direct labor. This includes receiving, numbering, processing, mounting, chemical mixing, shipping, and billing operations. On the average these functions probably will take up the time of 4 workers. Assuming these people are paid at an average of \$1.50 per hour, 40 hours per week, the total direct labor costs are \$12,480.

The next item, working counter-clockwise around the chart, (Figure 2) is supervision. This operation is not

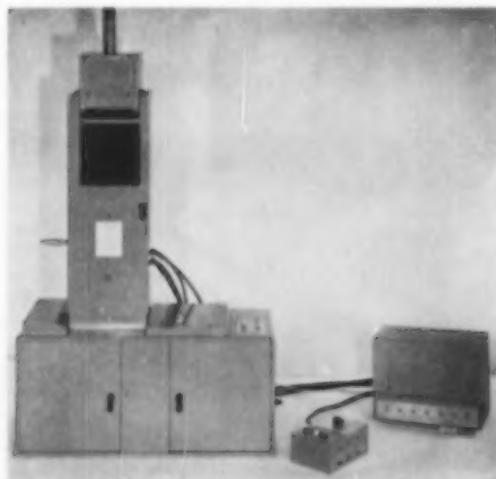


Fig. 3. Kodak Roll Paper Color Printer, Model 1R, list price \$1,850, for color printing from transparency originals.

Table II

ESTIMATED OPERATING COSTS FOR ANNUAL VOLUME OF 50,000 ROLLS 35mm EKTACHROME FILM DEVELOPING

Item	Amount
Direct Labor	\$12,480
Administrative Labor—Management	2,500
Maintenance Labor	780
Employee Benefits:	
For direct labor	499
For other labor	131
Materials:	
Chemicals	2,500
Readymounts	5,500
Packing supplies	2,500
Depreciation	2,500
Other Overhead Costs	480
Delivery Expenses	3,000
Total Estimated Expenses	\$32,870
Total Estimated Expense per Roll	65.7¢

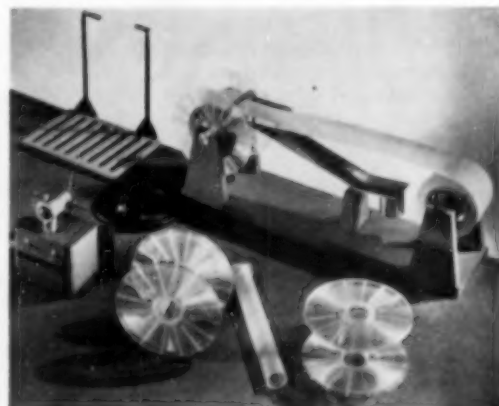


Fig. 4. Kodak Processing Reels for use with short lengths of color print paper in a color finishing setup having a capacity of 100,000 prints yearly.

large, so it is assumed that the owner or manager will be able to provide the necessary supervision, and also handle the bookkeeping and payroll work. It is expected that a large share of his time will be devoted to black-and-white operations, so an arbitrary allowance of \$2,500 has been set up for his work in color.

Maintenance labor can probably be provided by the same persons who take care of the black-and-white equipment. This includes routine repair, cleaning, and preventive maintenance, and is estimated at 2 hours per day. At an hourly rate of \$1.50, the estimated cost for the year is \$780.

Employee benefits cover FICA and State Unemployment Insurance Taxes. These will vary from one business to another, and in this example have been estimated at 4% of the payroll, or a total of \$630.

Chemical costs work out to roughly 5¢ per roll, or a total of \$2,500. This assumes that the 10-gallon size packages of chemicals will be used for the original mix, and that the replenisher chemicals will be obtained in the 5-gallon size. An allowance of 10% for spillage has also been included.

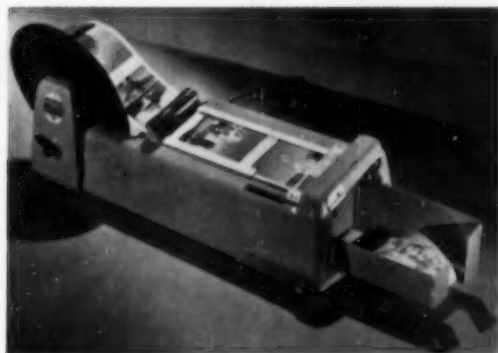


Fig. 5. Kodak Roll Paper Cutter, Model 1, list price \$200, for use in color processing laboratory using Type R print paper.

Readymounts have been figured at 11¢ per roll, or a total of \$5,500. Packing supplies include transparency slide boxes, wrapping papers, etc., and have been estimated at 5¢ per roll, or \$2,500.

For depreciation, to keep the illustration simple, it is assumed that the average usable life of equipment will be 5 years and that there will be no salvage value. Depreciation, therefore, is computed as 20% of the original cost, or \$2,500.

Other overhead expenses include rent, utilities, maintenance supplies, manufacturing supplies, office supplies, replacement film, etc. These are covered by an arbitrary allowance of \$480.

Delivery expense includes an allowance of 6¢ per order. This would cover either a 6¢ postage charge or a 6¢ pickup and delivery charge. Deliveries undoubtedly would be made in the same manner and using the same facilities as are employed by the black-and-white department.

It is assumed in this example that there are no expenditures for advertising, customer service, or other special selling efforts.

This completes the estimate of expenses. The total is \$32,870, or 65.7¢ per roll. With these figures and an estimate of his annual income, the color finisher can determine his estimated profit.

Capital Requirements

Now for the capital requirements. Since the business is occupying rented premises, equipment and working funds are all that need be considered. Equipment needs totaled \$12,500, and if the "three months rule" is applied to the estimated expenses, working capital needs are established at roughly \$8,250. Total capital requirements, therefore, are \$20,750.

Hypothetical Case No. 2 involves the manufacture of Type R prints. An annual volume of 50,000 orders and 100,000 prints has been assumed. Reports from makers of Type R prints indicate that the number of prints per order may average anywhere from 2 to 4, so it is assumed here that the average is 2. It is further assumed that half the prints are of the regular $3\frac{1}{2}'' \times 5\frac{1}{2}''$ size and the other half are the wallet $2\frac{1}{2}'' \times 3\frac{1}{2}''$ size.

In this example, one must consider a new factor—waste. An allowance must be made for make-overs

Table III

ESTIMATED EQUIPMENT REQUIREMENTS FOR INSTALLATIONS USING KODAK COLOR PRINT MATERIAL, TYPE R
Annual Volume—100,000 Prints Waste Factor—35%

Item	Approximate Cost
Kodak Roll Paper Color Printer, Model 1R	\$1,850
Kodak Processing Reels, Hard Rubber Tanks, Mixer, etc.	500
Processing Sink	750
Control Equipment	125
Paper Storage	250
Kodak Roll Paper Cutter, Model 1	200
Plumbing and Temperature Control	
Cooling equipment	300
Heating equipment	425
Plumbing	300
Inspection, Billing and Shipping	100
Air Conditioning Equipment	400
Total	\$5,200
Allowance for Contingencies, 10%	520
Allowance for Space Alteration	280
Total Estimated Equipment Costs	\$6,000

and losses due to short paper lengths. This allowance must be made not only in paper consumption, but in chemical usage, labor costs, and equipment requirements as well. Waste can be reduced as production volume or plant efficiency is increased, but never can be eliminated entirely.

For this example a waste factor of 35% has been assumed. This means calculating an equivalent of 135,000 prints per year, instead of the 100,000 to be delivered to customers. Average daily production including make-overs, therefore, is 319 prints.

For this operation estimated equipment requirements are \$6,000. This includes a Kodak Roll Paper Color Printer, Model 1R, at \$1,850 (Figure 3), Kodak Processing Reels (Figure 4), Hard Rubber Tanks, a Processing Sink, control equipment, a household refrigerator for storage of unexposed paper stock, a Kodak Roll Paper Cutter, Model 1 (Figure 5), plumbing and temperature control, a small amount for inspection, billing, and shipping, and air-conditioning. As in the previous example, a 10% allowance has been made for contingencies and an additional small amount for space alteration.

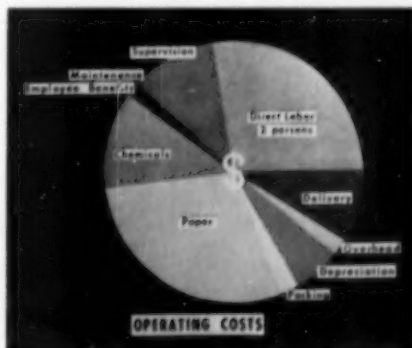


Fig. 6. Distribution of operating costs for hypothetical color print processing installation using Kodak Color Print Material, Type R, annual volume 100,000 prints.

The estimated operating costs (Figure 6) have been prepared in much the same way as for the Ektachrome example, except for the necessary allowances for waste.

Direct labor again is the largest single item of expense. It includes receiving, printing, chopping prints, printer control, paper supply and handling, chemical mixing, processing, inspection, assembling, packing, billing, and shipping. It is estimated that two persons can handle this work. Assuming they work 8 hours per day, 5 days per week, at \$1.50 per hour, direct labor will cost \$6,240.

Again, going counter clockwise, it is assumed that all other work except maintenance will be done by the owner or manager, and an arbitrary allowance of \$2,000 has been included for him. Maintenance has been estimated at 1 hour per day at \$2.00 per hour, or a total of \$520.

Employee benefits expenses total \$351 and provide for FICA and State Unemployment Insurance Taxes at an estimated rate of 4% of payroll.

The estimate for chemicals is based on 3 1/2-gallon packages purchased in case lots for the original mixes and maximum replenishment from 5-gallon packages of replenisher. At an estimated cost of 5.6¢ per foot, including waste, the allowance for chemicals totals \$2,362. Paper consumption has been figured at 169 rolls at \$32.89 per roll, or \$5,558.

Packing supplies include the cost of double pocket and shipping envelopes, at \$10 per thousand, one envelope for each order. Since 50,000 orders are involved here, the allowance is \$500.

Depreciation is again figured at 20% of the original cost, and in this instance amounts to \$1,200.

Other overhead expenses—rent, utilities, manufacturing supplies, office supplies, insurance, replacement film, etc.—have been estimated arbitrarily at \$480.

Delivery expenses are estimated at 3¢ per order or \$1,500. No advertising, selling, or customer service expenses are included.

Total estimated expenses are \$20,711, or 20.7¢ per print.

Once more, estimated profit can be determined by comparison of the estimated total expenses with estimated total income. Capital requirements, using the

Table IV

ESTIMATED OPERATING COSTS FOR COLOR PRINT PROCESSING INSTALLATIONS USING KODAK COLOR PRINT MATERIAL, TYPE R

Annual Volume—100,000 Prints
Waste Factor—35%
Processing Equipment Used—Reels

Item	Amount
Director Labor	\$ 6,240
Administrative Labor—Management	2,000
Maintenance Labor	520
Employee Benefits:	
For direct labor	250
For other labor	101
Materials:	
Chemicals	2,362
Paper	5,558
Packing supplies	500
Depreciation	1,200
Other Overhead Costs	480
Delivery Expenses	1,500
Total Estimated Expenses	\$20,711
Total Estimated Expense Per Print	20.7¢

formula, add up to \$6,000 for equipment and approximately \$5,200 for working capital, or a total of \$11,200.

An interesting point in this last example is the effect of waste on costs (Figure 7). As mentioned previously, the waste resulting from make-overs and short lengths affects more than just paper. Chemicals and labor are also affected, and sometimes equipment needs as well. In this instance, if the waste factor had been 50% instead of 35%, estimated total operating costs would have been \$23,200 instead of \$20,700, or 23.2¢ per print instead of 20.7¢. If waste were to be reduced to 20%, the estimated total operating costs would have been \$19,800, or 19.8¢ per print.

The effect of these cost variances on profits, of course, is more significant, and proper control over waste can easily make the difference between an acceptable and an unsatisfactory return on investment.

It is important to remember that the figures just reviewed are examples only and purely hypothetical. The only way to prepare a financial plan for any business is through consideration of the various factors that apply specifically to that business. Perhaps these estimates may give some ideas, but that is as far as they should be used.

An amusing incident took place a few years ago in Honolulu when the first 35mm Kodachrome processing machine was being installed there. A local man was hired to do the plumbing work. As he took the blueprint and looked over the maze of pipes, pumps, and valves required for the chemical feed lines, the filtration and recirculation system, the overflows, the drains, and what have you, he shook his head and then muttered, "Either you planty crazee, or you planty smart!"

The prospective color finisher might well be described in the same way as he considers the advisability of going into color finishing. Let's hope that his decision, whether it be to dive in or stay out, proves that he is "planty smart."

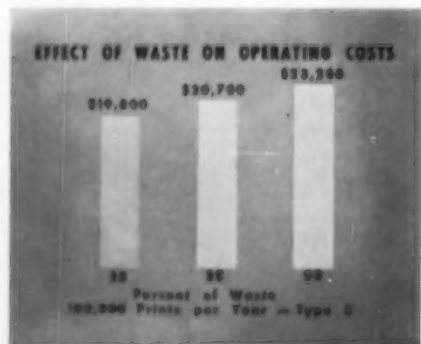


Fig. 7. Makeovers waste not only sensitized material but also labor and chemicals so the control of waste has a profound effect on costs and profits.

COLOR TRANSPARENCIES AND PRINTS—VIEWING CONDITIONS CONTROL THEIR SUCCESS

Betty Haithwaite*

ABSTRACT

The appearance of color prints and transparencies will vary according to the viewing conditions. The nature of this variation and its causes are discussed. How this affects the inspection of color photographs by the processor is pointed out.

IT IS A GENERALLY ACCEPTED fact that if you ask two people to describe the colors of objects they have recently seen, their descriptions will vary by quite a bit. The longer the time interval between seeing the scene and describing it, the more different the descriptions will be. If you then show these same people one photograph of this scene, it is entirely possible that only one of them will accept it as a reasonably good reproduction of the color of the objects. There is also a chance neither of them will accept it. The photographer would like to please both of these people with the same photograph—in fact, his aim is greater than that—not just two, but all people.

When analyzing the factors involved one's first reaction might be that all people will like the picture when its colors exactly match those of the subject. Even if pictures like this were possible, it is debatable that they would be accepted by all people. Studies have been made that show, where flesh tones are concerned, accurate reproduction may not be preferred. In fact, the preference may be for a more yellow reproduction than the original subject. This was brought out by experiments in which various people were shown a series of pictures of their loved ones. One of the pictures represented the actual color of the flesh. In each of the other pictures the flesh color was slightly different. When asked to select the picture in which the color of the flesh tone was closest to the color of the skin of the person pictured, in almost all cases a more yellow reproduction was selected. It must be noted that the person in the photograph was not present as the pictures were being judged. Such is the case for most photographs—very infrequently is the subject present.

If accurate skin tone reproduction is not a prerequisite, then it is possible that the same is true for other colors.

Therefore, one must look elsewhere for a prescription for pictures that all people like. Upon closer examination of the problem and study of customer preferences

in pictures, it appears that no clear cut specifications are possible—at least, not at the present. The best one can do is to look to statistics for an answer. Over a long period of time some agreement can be reached on the type of results that will please most of the people most of the time.

The main concern here is not about what people like but, how one can tell if he has produced a picture that will be acceptable. Assuming that it is known what kind of a picture meets these requirements, then the problem is—under what conditions shall one view the results?

To illustrate the extent of the problem to himself the reader may try the following experiment. Take a series of slides, bind them with CC filters or with filters of the Wratten 81 or 82 series. Then project them in a completely darkened room. The over-all color balance shift due to the presence of the filters should not be noticed. These conditions of projection are not unlike what the customer may use for viewing the results. But this is not the only way he may choose to examine them.

To demonstrate to oneself what the customer may discover about the pictures, project two of the above side by side with two matched projectors or view them side by side over an illuminator. Note the evident difference in over-all color balance.

The important thing that this demonstration points out is that as the viewing conditions changed, so did the individual's evaluation of the color balance. Why was this the case? It is a proven psychological principle that the eye will compensate for any color off balance of one object when it is alone in the field of view as each transparency was when first projected. It is also true that the eye is a good discriminator of differences when a comparison situation exists. This was demonstrated with the side by side comparison of the two transparencies. From these demonstrations it is evident that viewing conditions are a contributing factor in determining what we see.

This is true for prints as well. Take any color print (preferably one without a white border). Place it in the center of a large piece of black paper. Illuminate it with a fairly strong light. Quickly replace the black

* Eastman Kodak Company, Rochester 4, New York. Presented at the Color Processing Conference sponsored by the Technical Division of the PSA in Rochester, New York, 25 May, 1956. Received 13 June, 1956.

paper background with a white one. Notice how dark the same print looks. Turn off the bright light and view it under normal room lighting. It looks much darker.

With the bright light on again, place the print successively on backgrounds of various colors. Note that the print tends to appear more blue if the background is yellow or more yellow if the background is blue. In other words, it takes on the color complementary to that of the background. The effect may be favorable or unfavorable. The reason for the changed appearance can also be explained from the standpoint of psychological factors.

Sometimes when a print is made a transparency is available with which to compare it. The acid test of a good print should be that it looks like the transparency.

The color finisher can assume that the customer is satisfied with the transparency when he sends it in for printing. Can he make the print look as snappy as the transparency? The answer may be yes, but only when the conditions of viewing are the same for each. In other words, they both must be viewed in a darkened room. The slide should be in one projector and a clear mask in the other so the print can be flooded with white light. Whereas the color match may not be perfect, the contrast of the two is definitely closer than when the transparency is viewed alone in a darkened room and the print is viewed under its conventional conditions—in a lighted room.

So much for the psychological factors that influence individual judgment of photographs. A study of the color characteristics of the viewing illuminants used by customers will yield a wide range of colors from daylight at one extreme to household- or tungsten-type lamps at the other. All combinations of these might be used also. It is obvious that to try to check the acceptability of a picture over this wide range of illuminants is not practical. The difference in color between daylight and tungsten light can be noticed under certain conditions. For instance if one is outdoors at twilight or shortly after dawn, he may be aware of how yellow the indoor lighting is. When he goes indoors, this yellow appearance disappears and the lights appear white. When viewed simultaneously as in the case of a daylight and a warm white fluorescent tube in the same fixture, the former is blue and the latter yellow. It is only logical then that a source between the two be selected as a standard.

Because the human eye changes in its evaluation of the color of objects under varying conditions, it cannot be relied upon to help pick the proper viewing illuminant. The color temperature designation is a useful specification. It is a means of describing colors using the so-called Kelvin System. A color temperature of about 4000 Kelvin is recommended as a proper viewing illuminant. There are pitfalls, however, to completely relying on this rating also.

The energy distribution curves shown in Figure 1 represent two sources which look very much alike. Notice the different locations of the sharp peaks of radiations in both sources. It is these peaks that will cause reds to look more orange under the right hand source and blues more violet under the left hand one.

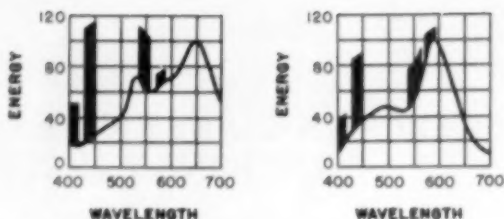


Fig. 1. Energy distribution curves of two fluorescent lamps which look very much alike.

What significance does all this have for the color finisher? How can he use the above information to advantage?

First, it is evident that the viewing of transparencies in a darkened room is a good way to convince oneself that the color balance of a picture is very satisfactory. A great many different pictures will appear to be in satisfactory balance when viewed this way but when selected ones are viewed simultaneously, their true balance is seen. Off balance can be compensated for by the human eye. If the customer always viewed his transparencies in a darkened room, he wouldn't be sensitive to slight balance shifts. But he doesn't. Then, too, suppose he wants a print made? The poor balance effects will then be obvious. Therefore, results should be compared with a standard picture of known acceptable balance.

Second, a print will look most satisfactory when it is viewed in a bright light against a black background. However, whom are we fooling? Only ourselves. To be realistic, one should consider how the customer will look at them and select the laboratory print viewing conditions with this in mind. An amount of light from about 25 to 100 foot candles of illumination should be incident on the prints at the inspection desk.

Third, the quality of the radiation of the viewing lamp must be carefully selected. For best results it is recommended that tungsten lamps of a relatively high color temperature be used. In cases where fluorescent lamps are desired, G.E. Photocolor or Sylvania Super Deluxe Cool White tubes are satisfactory. For transparencies, the Kodak Color Transparency Illuminator with a color temperature of about 4000 K is recommended.

When setting up a photofinishing desk in a retail store, it is wise to consider the above recommendations. If the customer is provided with the proper viewing conditions to check his pictures, the color finisher will have more assurance that he will be pleased with the result—at least until he gets them out of the store.

Thus there are both psychological and physical factors that are important. The more one knows about these factors and how they affect what is seen, the better one will be able to evaluate pictures to the customer's satisfaction. The main factor is to select viewing conditions so that when a picture has passed the laboratory's inspection, the result will be pleasing to the customer. Then the color finisher will have done his best to produce a picture that most of the people will like most of the time.

TRANSPARENCY DUPLICATION MATERIALS AND PROCEDURES

Ira B. Current, APSA*

ABSTRACT

Color Duplicating Films are available in 16mm, 35mm and in sheet film form which can be used by the color finisher to provide good quality duplicates by direct printing, without resorting to the use of masks. Permissible variations in processing to achieve modifications in gradation from those obtained by the standard procedure are indicated.

IN THE color photofinishing industry there will always be a market for duplicates of color transparencies. These will generally be in the form of slides of 1:1 size ratio, although on occasion enlargements of selected areas or reductions from large transparencies will be required. Many of these will be single or low multiple copies of individual transparencies, while others may represent large orders from only a few transparencies. The customer will range from the amateur who wants only a few copies for sending to near relatives, to the commercial user who may require in the hundreds of a given slide or sets of slides.

There will be requirements for duplicates that are equal to or better than the original; where presentation of detail, color quality, and color balance are such as to require careful masking, separation printing, and other refinements to meet the required specifications. The present discussion is limited to the making of satisfactory "commercial quality" color duplicates by direct printing from an original onto the color duplicating material.

The first thought that might occur to a finisher when called on to fill his first color duplicating order would be simply to reproduce the original on the original "camera" or "taking" film; perhaps the same type of material as that which was used to make the original transparency. And the first venture might well lead to success—a duplicate acceptable to the finisher's standard of quality as well as to the customer—provided the subject matter was such as to disguise the faults of the procedure. In most instances, however, such a duplicate, made on the taking film itself, would suffer from one or more of the following: (1) too high contrast; (2) color degradation; (3) excessive change in color balance from one end of the scale to the other, i.e., "crossed curves"; (4) excessive graininess; and (5) amplification to an unacceptable degree of the toe stain found to be acceptable in the original. The reasons for these shortcomings have been fully discussed elsewhere, however, it may be stated that most, if not all of them, can be explained simply as the result of a factoring of the various deficiencies that of necessity may exist in the color rawstock.

In view of the above, manufacturers have provided material designed especially for making duplicating slides or prints. Ansco provides AnscoColor Duplicate Film T-238 (16mm), and T-538 (35mm) on "Cine" stock for making 16mm motion picture prints from color reversible originals, and for making 35mm slides and strip-films.

* Ansco Division of General Aniline & Film Corporation, Binghamton, New York. Presented at the Color Processing Conference sponsored by the Technical Division of the PSA in Rochester, New York, 26 May, 1956. Received 25 April, 1956

A sheet film T-638 is also provided and while this product is similar to the "Cine" material, its photographic characteristics are not exactly the same. Of course, the sheet film is considerably thicker, and carries a gelatine NC coating of the backside; whereas the 16mm or 35mm materials do not.

The gradation of these products has been chosen to yield the best compromise between adequate color saturation and adequate tone reproduction. Furthermore, the sensitization of the individual emulsion layers has been adjusted as far as is practicable to avoid degradation product color losses in duplicating.

Processing, in general, is similar to that employed for Ansco Color materials, with the specific procedure employing a #502A2 first developer and #654 color developer. For the benefit of those who may not be familiar with the Ansco Color Duplicating processing procedure, the steps for the Type 538 film are shown in Table I.

Table I

PROCESSING PROCEDURE FOR ANSCO COLOR DUPLICATING

Step	Solutions	Minutes
1	First Developer (#502A2)	*8
	First Developer Replenisher (#520R5)	110cc/80 sq. in.
2	Short Stop (#858)	2
3	Wash	2
4	Second Exposure	1
5	Color Developer (#654)	*7
	Color Developer Replenisher (#654R1)	125cc/80 sq. in.
6	Short Stop (#858)	2
7	Hardener (#901)	4
8	Wash	5
9	Bleach (#2087-270A)	5
10	Wash	4
11	Fixer (#800)	4
12	Wash	10

* These are normal developing times intended for optimum performance of the product. Within limits, the developing times may be modified to secure variations in gradation and color quality. However, it may be shown that deviation from standard conditions, while perhaps necessary for an unusual job, will not result in best performance for general work.

In general, higher agitation rates will tend to lower the developing times required. Care must be taken, when developer time variations are employed, to see that they are not carried to such excess as to degrade the quality of the prints being made. Excessively short first or color developing times, for example, will tend to cause poor curve conformity, or lack of acceptable color balance from one end of the scale to the other; low color saturation

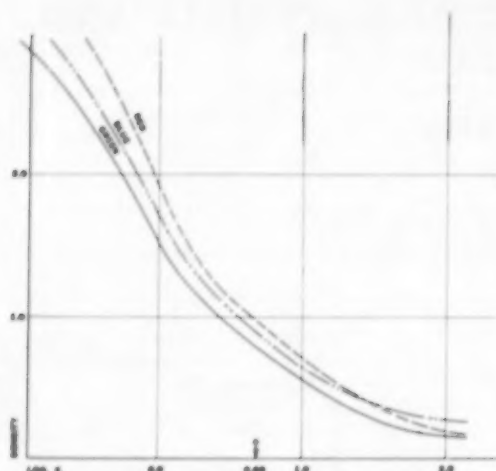


Fig. 1. Typical integral density sensitometric curves for the red, green, and blue recording layers of Ansco Color Duplicating Film T-538 developed for normal first and color developing times.

tion and low maximum density. Excessively long first developing times will tend to reduce maximum density, give poor color quality, and non-conformity of the characteristic curves of the three emulsion layers.

Figure 1 shows integral density curves, read through red, green, and blue filters, obtained by sensitometry of Ansco Color Duplicating Film Type 538, developed for the recommended 8 minutes in the first developer, and 7 minutes in the color developer. The lower halves of the curves have a soft gradation, a gamma value in the vicinity of 0.8, for pleasing reproduction flesh tones, and semi-highlights. The upper halves, yield gamma values in the vicinity of 1.8 to provide strength in the shadow details.

If the first developer time is reduced to four minutes, the curves become like those in Figure 2. They more

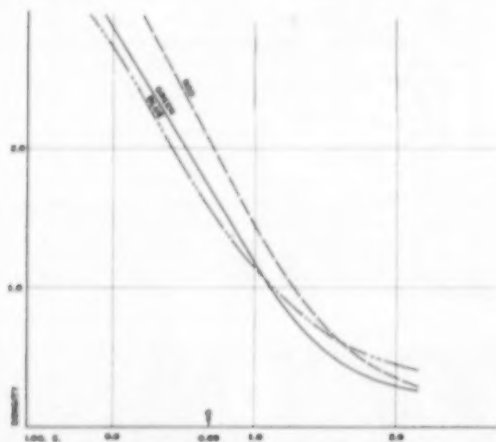


Fig. 2. Curves showing the effects of reducing the first developer time to 4 minutes with 7 minutes color developer time. Gradation is much steeper than shown in Fig. 1.

nearly approach a straight line, but the over-all gradation is steeper with a gamma in the vicinity of 1.8, and a speed reduction of about $1\frac{1}{2}$ stops must be compensated for. Such a modification might prove to be desirable in a special case where higher over-all brilliance and linearity is required.

In order to illustrate the effects of increasing the first developer time, curves from film developed for 12 minutes showed a further reduction of gamma in the "high-light" half of the curves, Figure 3. Some reduction in the shadow gradation may be observed, but here the shadow quality is lost because the maximum density has been reduced. The speed has been increased by 2 stops. Adjustment by increasing the first developer time should not be carried this far.

Excessive reduction of color development is illustrated in Figure 4, where the color developing time has been reduced to 4 minutes. A review of the practical duplicates made under these conditions show very poor curve conformity, poor saturation, and a low maximum density. Speed is increased about 2 stops. In general any reduction of color developing time should not be resorted to, without expecting losses in quality.

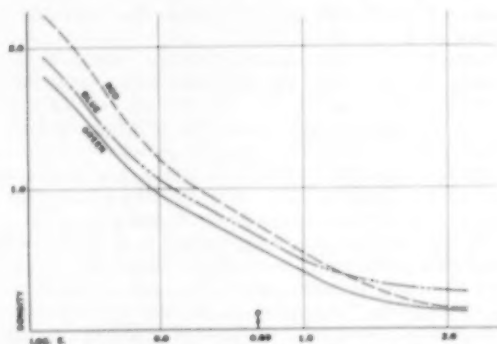


Fig. 3. Effect of increasing the first developer time to 12 minutes, with color developer times at 7 minutes. Gradation is excessively flat, and the maximum density (not shown in the curves) is reduced to an unacceptable degree.

Figure 5 illustrates the curves obtained by increasing the color developing time. In general the result is somewhat similar to that obtained by decreasing the first developer time. Color saturation is increased, but at the expense of increased gradation, particularly in the highlights.

The gamma values measured tangent to the first developer time curves at densities of 0.8 and 1.8 have been plotted in Figure 6, and show in another way the effects of these modifications. The color developer curves have been analyzed and plotted in a similar way in Figure 7. Figure 8 gives relative speed relationship when the developer times have been modified throughout the extreme that has been mentioned.

It should be noted in spite of the similarity of the Anscochrome and Ansco Color processing procedures, these two products should not be processed in the same "line" because the reaction products are not the same, and those from one of the products would be detrimental to the quality of the other. A single line cannot be re-

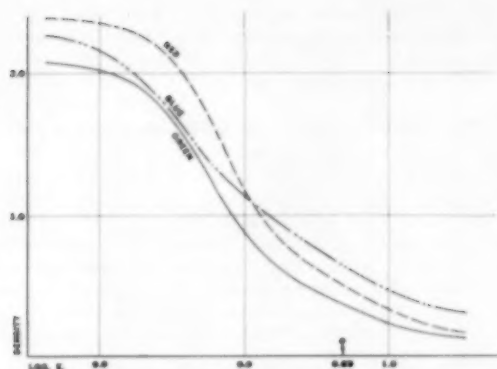


Fig. 4. Lowering of the color developing time to 4 minutes, after 8 minutes first developer gives poor "curve conformity" (variation in color balance at different density levels), considerably higher middle density gradation, and an unacceptably low maximum density.

plenished and controlled to give optimum quality on these two groups of products. In those installations where only one processing line is available, the first and color developers may be replaced to change the machine from one group of products to the other. Particular care must be taken, however, to see that the other solutions are maintained to their proper performance level.

Some modification of the above processing procedure is necessary for the T-638 sheet films.

Color processing equipment of several designs may be employed for both T-538 film and T-638, although, some allowances will have to be made for variations in type and degree of agitation. The Type 538 film lends itself to processing in 35mm magazine film lengths on standard photofinishing equipment. Of course, long lengths may be processed on continuous type machines. The T-238, 16mm film naturally, is processed on continuous machines; although it is capable of being processed by

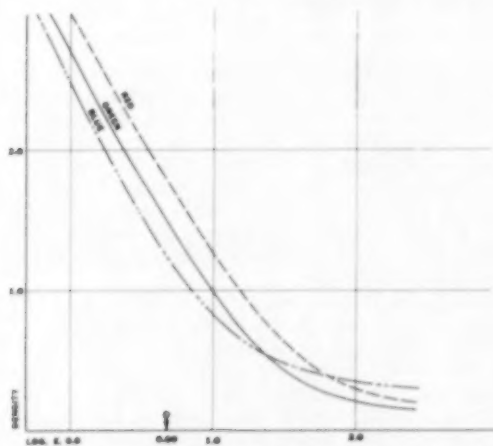


Fig. 5. Increased color developing time of 14 minutes, after the normal first developer time of 8 minutes, gives higher contrast, not unlike that shown in Fig. 2. Where the higher contrast can be tolerated, the better color saturation and fidelity may prove to be desirable in some instances.

means of old fashioned racks and tanks, or in spiral or apron reels.

No matter what processing method is arrived at, a standardization procedure must be established for it in order that control can be maintained to produce the level of quality required. Then, if the method of processing is modified, or another type of processing apparatus selected, the procedures will have to be modified to meet the newer conditions. These standardization programs are essential to meet the economical requirements through elimination of wasted materials and time resulting from the interminable experiments and trials and errors that ensue from lack of standardization. Even with a well organized, controlled laboratory set-up, a good deal of time will have to be devoted to experimental and trial and error work for trouble shooting problems that will arise.

Sensitometry is perhaps the most useful tool in the maintenance of a color processing line; although in small laboratories this may appear to be an unnecessary burden. Nevertheless, when wisely used, it can prove

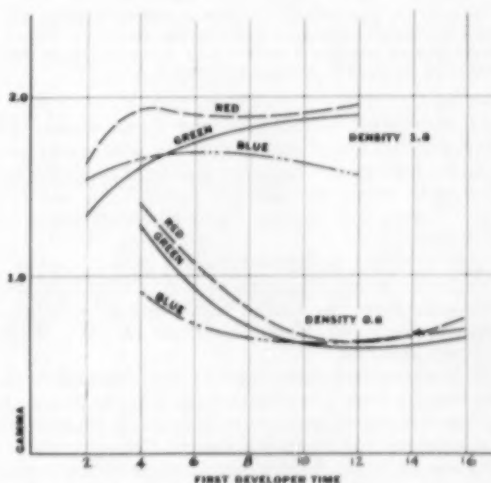


Fig. 6. The gradations of the integral density curves measured at a density of 0.8 (middle high lights) and at a density of 1.8 (middle shadows) have been plotted against first developer time. Development has reached a relatively stable progression within 8 minutes, which continues for some time after that.

to be of service even in the smaller set-ups. It is possible to obtain already exposed "control strips" from Ansco, along with specimens of the same material that have been processed in a "standardized" line, for comparison purposes. Measurement of integral color densities at prescribed steps serve as a means of plotting the day to day or hour to hour performance of the line. A plot of this type is much more suitable than carrying the condition of the line in the head of the operator. Records, or plottings, are available to the plant supervisor, to relief operators, or to anyone who might have occasion to inquire as to the status of the processing line.

The slides used for demonstration were made by contact printing: The original was in contact with the duplicating material in a printing frame, exposed under

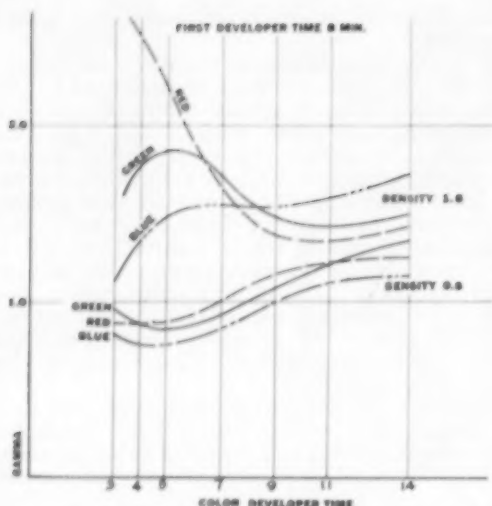


Fig. 7. A plot similar to that shown in Fig. 6, but with the color developer time as the variable. Color development reaches a satisfactory progression at developing times of 7 minutes and above.

an enlarger with nothing in the light beam. This method may not be entirely suitable for production printing, and it will usually be found that some type of optical printer will afford the greatest convenience and flexibility. Figure 9 shows an Emby-Homrich 35mm Optical Printer.

Figure 10 shows the Emby-Homrich Enlarger set up for use with the 35mm magazine printer. This equipment is available from the Emby Photo and Film Machine Company, Inc., 761 North Highland Avenue, Hollywood 38, California.

The Revere Cinelarger, used in combination with a Leica camera body (less lens) for a film magazine, has been found a convenient means of making double frame 35mm enlarged duplicates from single 16mm frames.

The assembly and fabrication of many different printing arrangements is possible to meet the requirements of

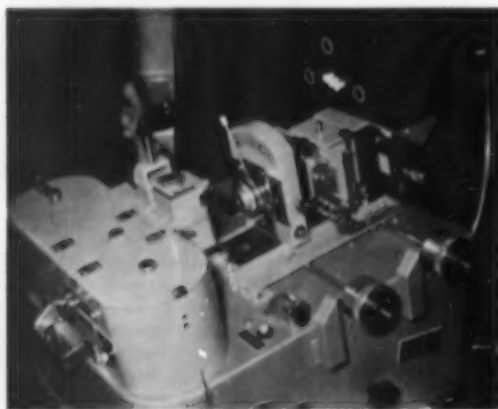


Fig. 9. Emby-Homrich 35mm double frame optical printer.

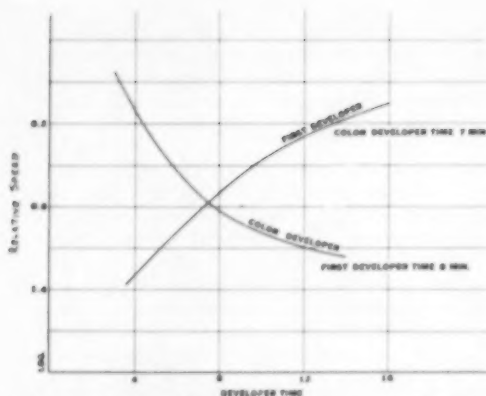


Fig. 8. A plot of first developer times, and of color developer times, with normal color and first developing times in each instance, indicates the relative speed relationships that must be compensated for with such processing modifications.

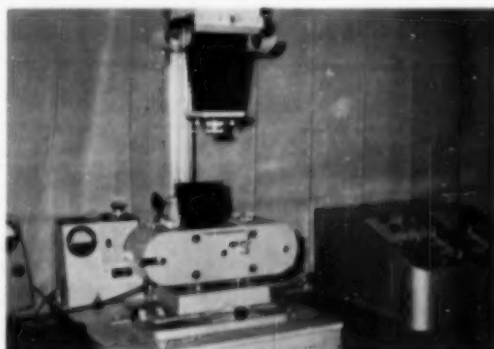


Fig. 10. The Emby-Homrich Enlarger set up for use with the 35mm magazine printer.

a given laboratory. One problem, however, may prove to be a knotty one: the selection of a lens that will give suitable definition when used near its secondary focus for 1:1 ratio. This may call for close co-operation with a lens manufacturer for the production and/or selection of a suitable lens. Testing may be done by using the lens with a given piece of equipment to make duplicates from several different transparencies having characteristics that would reveal any definition loss, and then examine them critically.

Anso Color Duplicating film is in the vicinity of 8 to 10 stops slower than Anscochrome tungsten film. The material is designed for a minimum of filtration when used under average printing conditions with a tungsten light source. Normal production variations, age of the material, type of original being printed, and the particular characteristics of the printing equipment used will sometimes require considerable filtration to obtain a suitable balance of the duplicate.

The material is inherently a fine-grain material. However, when processed to higher contrast, it will tend to emphasize any graininess appearing in the

original transparency being duplicated, and this effect is sometimes wrongly assigned as graininess in the duplicating emulsions themselves. The Ansco Color film gives reasonably high resolution, in the vicinity of 50 lines per mm.

First approximation to best exposure time may be determined by making a test exposure series using an average transparency. Once this has been established, a skilled printer can guess exposures for other transparencies with an assurance of 50% to 75% accuracy, depending on the quality required. Automatic exposures depending on the total integration of the picture area can be expected to increase this performance. A PE cell probe to select critical or important areas in the scene being printed can be used to obtain closer control of exposure, favoring these areas, but this method requires considerable time and skill in interpretation of the readings.

While the 35mm Ansco Color Duplicating film T-538 has been referred to in most of the above discussion, the 16mm film T-238, and the sheet film T-638, are of the same general type, and are designed to meet the requirements for motion picture work, and for large displays. The sheet film has incorporated in the base, and

in the surface coating layers, UV absorbing dyes to retard the fading effects of prolonged exposure to light.



Fig. 11. Double frame 35mm optical printer and accessory control equipment at Pavelle Color Inc., New York, N. Y.

TEN YEARS EXPERIENCE IN COLOR PHOTOFINISHING

Leo S. Pavelle, APSA* and Lloyd E. Varden, Hon. PSA, FPSA†

ABSTRACT

Some of the problems which were faced in this pioneering effort to establish an independent color finishing service are described. Some of the preconceived notions which were proved wrong and some concepts that experience showed we were justified in assuming are presented.

MOST PHOTOFINISHERS have tremendous faith in their common sense. A large part of the success of each of us in this industry, when you come right down to it, has been due to reasonably good common sense judgment, backed up by a lot of hard work. Of course, it required a few years of experience before we gained full confidence in our common sense decisions, but once we acquired this experience, and felt the "knack" of photofinishing—technically, business-wise, saleswise, and so on—we thought that the remainder of our future would rest on the ability to make at least 3 correct decisions out of 5.

We all know photofinishers who extended the common sense approach beyond the limits justified by their experience. Being *wrong* in their judgments 3 times out of 5, they went out of business. Whenever we learned of such instances it fortified the logic of our own business conduct. And, in due course, we tended to assume—in a broad sense—the attitude of an "infallible authority" as far as photofinishing was concerned.

It is not our intention to suggest that those of us who have been fairly successful in photofinishing have

simply been lucky. There is no question about the importance of good common sense in putting a business operation on its feet. But we do believe very strongly, especially after 10 "rough" years in color photofinishing, that the extension to color finishing of the same common sense attitudes, which *appeared* to be sound in black-and-white photofinishing, is basically wrong.

The arguments to support this rather blunt statement were derived from hard-earned experiences in color finishing. There were times when it was difficult to readjust our thinking to comply with the facts which color finishing experience evolved. In the end, however, it was color finishing which taught us that what we had thought were sound, common sense technical judgments in black-and-white finishing were nothing more than *assumptions* that just happened to be workable in our restricted area.

Now an assumption is the acceptance of an idea or principle without real knowledge, or any thought that it might be subject to error. In starting our black-and-white businesses, for example, we all assumed (quite properly) that as far as pleasing most customers was concerned, there were no unduly difficult technical problems to overcome. Yet, we *did* regard the business as a "technical" enterprise. However, more often than not, the success of most black-and-white finishers can be traced

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to completely non-technical abilities. Nevertheless, we could not help but build up a backlog of technical assumptions that influenced our common sense appraisals of any new developments in photofinishing.

The usual preconceived notions of the technical simplicity of black-and-white photofinishing are in fact invalid. The repeated warnings and admonitions of manufacturers regarding the necessity for following prescribed practices for best results are largely disregarded, because the latitude of black-and-white materials is so great in all directions that salable results can be produced by non-endorsed procedures.

A False Pattern of Thinking

This *apparent* simplicity of black-and-white finishing, which experience in the field does not seem to have corrected, has tended to establish a false pattern of thinking among photofinishers. In considering color finishing, for example, such thinking leads to opinions like, "If they can do it, we can do it," without regard for "how" they do it. The tendency is to assume that color finishing must be much easier to carry out than is implied by official recommendations.

We must profess—with a degree of humility probably acceptable even to Arthur Godfrey—that we at Pavele Color Incorporated ventured into the processing of amateur color materials in late 1945 with the blind courage of a Spanish bull and the naiveté of a new-born lamb. Some very broad and almost disastrous assumptions were made. The surprising thing is, when looking back to 1944 and 1945, that the few broad assumptions we made which proved later to be correct, were those which were based on obvious hunches. Anyone could have made similarly accurate predictions because they were obvious. We refer to such things as:

1. Amateur color photography would expand.
2. Color products for independent finishers would increase in number and improve in quality.
3. Technical advances would be made to simplify production problems without lowering quality.

What we were not able to predict, probably because of our black-and-white finishing prejudices, were the difficulties which were to arise from pure ignorance of amateur color finishing requirements and certain erroneous technical assumptions. We cannot discuss all of the things that we have learned along the way, but we hope that a few typical examples will show the fallacy of applying too much "common sense" in color finishing. Most examples are given just to illustrate the point and are not expected to have much practical value today.

Establishing Standards of Quality

One of the most perplexing things in color finishing is determining standards of quality, i.e., what the consumer wants. Even before Pavele Color Incorporated opened its doors for business we had found considerable diversity of opinion within our own ranks as to the most pleasing color balance and overall density level for prints. In an effort to be scientific in the matter we prepared long strips of prints made from a wide selection of

transparencies, each strip having a different color balance or different density level. These were spread out and judged by everyone in the plant, as well as by a number of other people. We agreed that we would be guided by the average opinion even if it departed quite widely from our personal opinions.

This test led us to adopt a decidedly warm color balance and a fairly heavy overall print density. If that was what people preferred on the average, that's what we would give them.

Within a few weeks the increasing number of complaints from dealers and consumers caused us to wonder a bit. But we had also accumulated a file of letters from customers stating, in effect, that our prints were better than those from the Kodak Company. And for some reason, each of these letters seemed to counter-balance 50 complaints. Nevertheless, it soon became apparent that a change in our standards was called for. As a matter of fact, during the first year of operation we made many changes. For a while it looked as though people did not know what they wanted, but eventually our color balance standard became just about the opposite from what it was in the beginning. A neutral or a slightly bluish gray scale balance was adopted and an overall print density much lighter than before.

We learned that people are more critical of pinkish clouds than they are of greenish faces. They prefer somewhat washed out highlight areas to dense shadows with no detail. We also found that people judge prints made from their own transparencies differently from the way they judge prints of unfamiliar subjects. We learned that complaints of a general nature from dealers have to be investigated individually and should not be considered as valid criteria for changing one's standards. In one investigation, after some dealers had complained that our prints were too light and others considered them too dark, we found that within a group of only 20 dealers the illumination level at the photofinishing counter varied from 7½ foot candles to 350 foot candles. And we have found instances where complaints about color balance came from people who were unable to pass the Ishihara Color Chart Test. Finally, we learned something that should have been obvious, that a quality complaint from a customer whose work was delivered *late* can be disregarded as far as influencing quality standards. The poorer the service, the more critical customers seem to become.

Technical and Engineering Experiences

It is probably in the technical and engineering areas that finishers have the biggest mental adjustments to make. We tried to adopt a technical attitude from the very start, but many things happened to demonstrate how difficult it is to get away from ill-founded assumptions even when you try to accept the technical approach.

For example, we rather went along with the prevalent concept in photographic practice that the manufacturers are often too cautious in their approach, and that it was not until an item got into the hands of the user that the manufacturer really learned how to make it work. Much of the testing and fussing around the manufacturer finds necessary to do has been looked upon as evidence of his lack of practical experience. As a result,

finishers are inclined to institute new procedures or alter equipment, sometimes without any pretesting, on the assumption that their experienced judgment is sufficient for making such changes.

During the designing and constructing of our continuous, roll Printon processing machine, Ansco had warned that they were unable to give any assurances that Printon film emulsions would withstand repeated contact with roller surfaces. The machine was to be 130 feet long, with over 200 bottom rollers which the emulsion side of Printon would have to contact. We figured this represented no problem if the rollers were made properly, and to avoid taking chances they were made of highly polished stainless steel, surface plated to a mirror finish.

When the first test roll of Printon film was run through the completed machine we were surprised (to put it mildly) that there were no pictures on it. The emulsion side of the Printon was as white as the base side: unquestionably the best whites we have achieved up to this day. In passing around the bottom rollers the emulsion had been worn away because the rollers failed to turn. It was a frightening thought when it dawned upon us that maybe the process could not be adapted to continuous machine handling. Then we began to make tests, fortunately finding a solution. Our beautiful, expensive bottom rollers were covered with gum rubber (initially) to create adequate friction between the emulsion and roller surfaces to cause the rollers to turn as the Printon web passed around them.

In the course of these tests we found that if the drive system was adjusted to maintain a higher web tension than originally planned, the lower rollers functioned better also. On one occasion this was apparently carried to an excessive extent because—believe it or not—the color prints came through the machine out of register by as much as an eighth of an inch. One of the emulsions had been slipped out of position relative to the others, but remained intact.

This machine gave us no further trouble for several months, and so we had every reason to believe that the only thing left to do was to keep it oiled, so to speak. But in those days our production volume was comparatively low, providing more than enough time for thorough maintenance. Not long afterwards, though, the production load increased and new troubles developed. Day after day, during some period of the processing run, the machine would be filled from one end to the other with Printon. Far too often, sections of such long runs would show emulsion digs and scratches. It took many weeks to isolate all of the reasons. The basic reason was the "freezing" of one or more of the bottom rollers, but no one thing was responsible for their freezing, as we assumed after finding the first cause.

We found that on very long processing runs the gum rubber roller coverings would be squeezed outward beyond the length of the roller to the bearing supports. Naturally, the roller would then not be free to rotate. But even after a crash program to change the coverings almost overnight to a plastic material, the roller freezing problem was not eliminated. In the haste to correct the difficulty it was not consciously observed when the rollers were removed from the machine that many were sticky. In the process of changing the type of covering, the bearings and roller shafts were thoroughly cleaned.

Thus, when no trouble arose for several weeks after the change it was reasonable to believe that the problem had been licked. But actually many rollers were about to freeze from causes other than the one we had observed at the time this cause was found. Cleaning the bearings and shafts eliminated these causes temporarily without them becoming evident. In due course, however, we found that silver, plating out on the stainless steel bearings, etc., in the first developer and fixing solutions also caused rollers to bind. Prussian blue deposits in the bleach and accumulation of tarry substances in the color developer did the same. Filtering the solutions at rates of 20 to 30 gallons a minute did not prevent the gradual build up of these deposits in the bearings. The complete answer was found only after instituting a rigid program of inspection, maintenance and regular replacement of parts.

Now as production volume continued to increase, more and more exposed rolls of Printon had to be held a few days prior to processing, especially on week ends and holidays. When these rolls were intermixed with others that were exposed a few hours before processing there were variations in the controls which seemed to indicate non-uniform agitation. There were other possible reasons, such as latent image changes during storage, but the tests we had made on such possibilities did not show the order of variation evident in the controls. Improved agitation seemed to be the answer. Special headers were installed over the first and color developer tanks for a separate solution circulation system to provide jet agitation. This was an expensive alteration to the machine which turned out to be completely unnecessary.

Knowledge of the fact that the jet system brought no improvement in processing uniformity was forced upon us, however. When the jet circulation rate was made sufficiently high to spread the solution uniformly over the emulsion surface, the pressure against the web made it flap back and forth, often causing the loops to contact and stick to each other. Even worse, if the web was not tracking perfectly in the center of the rollers, the non-uniform jet pressure across the web surface forced it off the roller quite rapidly. Therefore, the jet circulation rate had to be throttled down to a useless level, whereupon we observed that the processing uniformity was not impaired by doing so. Tests later showed no difference in uniformity with the jets at full pressure or completely off. The squeegee action of the Printon emulsion in passing around the bottom rollers, plus general solution circulation, had been doing an optimum job of agitation all along. The non-uniformity had arisen from entirely different factors which were pinned down in a later series of tests.

By no means were all of our hard-earned experiences restricted to processing equipment. The printing machines, for example, in spite of building and testing a prototype before constructing the production equipment, presented an equal number of problems.

One of the earliest concerned the coding range. We had provided a normal code button and two minus and plus buttons on either side of the normal. The exposure increment from one button to the next was the $\sqrt{2}$. Similar coding systems had been used on black-and-white machines, and in testing the prototype printer a

total of five code positions appeared satisfactory. Unfortunately, the color transparencies used in testing the prototype were not typical. We were amazed in our first weeks of production to find that people treasured such a large number of transparencies of the type we assumed were automatically thrown in the wastebasket. They not only kept them, they wanted prints, too. But in those early weeks we returned to the customer all transparencies which were not suitable for printing. Therefore, the limitations of the coding range did not come to light until customer and dealer letters began to pour in demanding that transparencies submitted to us be printed. The customers wanted color prints and not opinions, and the dealers wanted the business. Someone once said, "You catch hell if you don't accept a transparency and the same if you send out a poor color print. Therefore, you might as well take the dollar and print from anything."

When the policy was adopted to print all transparencies, the five position coding system proved to be far too narrow in range. The printers could not be taken out of production, and so the installing of additional code buttons was a fairly slow process. In the interim, the operators had to make use of a range switch mounted at the back of the machine whose normal purpose was for adjusting the photoelectric timing circuit for different Printon emulsions. Almost every week at least one operator would fail to restore the range switch to its proper position, resulting in numerous subsequent errors of exposure. By the time the printing machines were revised to be adaptable to any type of transparency, the coding range was extended from a -7 to a +6 button.

In addition to this particular exposure timing problem, another one came to light concurrently. The light source and optical system had been designed to give an exposure time of 2 to 3 seconds for a normal density 35mm transparency enlarged three diameters. But since underexposure with reversal materials leads to a higher than normal density, a good portion of transparencies received were so underexposed in the camera that print exposure times of several minutes were not uncommon. As a result, the entire illumination system was redesigned to give a much shorter exposure time for normal density transparencies, thus reducing the times required for dense transparencies to a tolerable limit.

As you can well imagine, with so many unexpected difficulties occurring, the wastage in production was exceptionally high. To a black-and-white finisher it was hardly conceivable for wastage to be as high as 50% on

some days, with an average of 30 to 35% day in and day out. Even after major equipment alterations, the wastage fell no lower than 25% for many months. It was clear that our control operations had to be expanded far beyond what any black-and-white finisher could possibly imagine to be necessary. Our control department even at the start was something unheard of in the finishing industry. We had a chemical analytical laboratory and a chemist, plus a separate sensitometric control laboratory and a man experienced in sensitometry, over which was a technical director formerly in the photographic industry. Before our production uniformity and wastage came into control, however, we had 14 people in our chemical and sensitometric laboratories, and many thousands of dollars worth of laboratory equipment. As a matter of fact, one's entire level of thinking toward personnel has to undergo marked revision when adding color finishing to a black-and-white finishing operation. The technical competence of a color finisher's employees, experience has taught us, spells his success or failure.

Unfortunately, though, even competent people have no magic wands. They have to work together over a period of several years and gain experience on the spot before difficulties begin to dwindle. And we doubt they can ever be made to reach zero even when the accumulated experience is passed down to new employees. But certainly the passing down of experience is very essential. We can cite an amusing example to support this, which was not very amusing at the time.

A large tank of a wetting agent solution was dumped down the drain causing vast quantities of foam to develop and back up through the sewer line that was common to our laboratory and an automobile parts company next door. Thousands of small auto parts were submerged in a sea of foam, for which we were responsible. We paid for the clean-up labor, etc., and swore that such a thing would never happen again. Wetting agent solutions were from then on dumped slowly along with a stream of water. But about a year later a new man was put on this particular processing machine who had not learned of the foam incident. The first time he dumped the wetting agent tank the auto parts company was again engulfed in foam, practically to the ceiling.

You will learn much from experiences in color photo-finishing. We hope that this brief review of some of our experiences will be helpful in preventing discouragement when similar events occur—which they will—in your own color undertakings.

REVOLUTIONARY DEVELOPING AGENT

A developing agent, called Phenidone, recently produced in the organic chemical laboratories of a famous British company, has achieved such swift success internationally in the photographic trade that applications to manufacture it under license have already been received from several countries, including the United States. According to the British Information Services, when Phenidone is used in place of Metol as an activating agent for hydroquinone, the resulting developer has a lower rate of

exhaustion than conventional developers and the solutions have better keeping properties. Ilford, Ltd., Ilford, Essex, England, is the manufacturer responsible for a chemical development which is rapidly dominating the field of photographic developer formulation and providing amateur and professional photographers alike with more satisfactory products for better photography. Ilford now has a USA sales organization at 37 W. 65th St., in New York City.

THE SOLUBILITY OF SILVER BROMIDE AND SILVER CHLORIDE IN AQUEOUS SOLVENTS*

M. A. Hill, C. W. Zuehlke, and A. E. Ballard

ABSTRACT

Solubility values were determined at 25°C for silver bromide in aqueous solvents containing some common ingredients of photographic developer solutions. Curves were obtained relating solvent capacity to: (1) Thiocyanate concentration in pure water and also in the presence of fixed amounts of carbonate, sulfite, and bromide; (2) Isopropylamine concentration in the presence of similar amounts of carbonate, sulfite, and bromide; (3) Sulfite concentration at various bromide concentration levels; (4) Bromide concentration at various sulfite concentration levels; (5) Sulfite and bromide concentrations varied simultaneously.

In addition, silver chloride solubility values were determined at 25°C for potassium oxalate solutions up to 1.3 molar.

ONE OF THE important properties of a photographic developer is its tendency to dissolve the silver halide grains in an emulsion. By uncovering internal fog centers and internal latent image, the erosive action of a so-called solvent developer may result in higher fog values and a darker image. Solvent action also can promote "dichroic" fog formation by physical development on catalytic nuclei in the gelatin phase.

In photographic development of the customary "direct" type, the silver halide grains may be attacked by the developing solution in two ways. The more obvious reaction is the direct conversion of silver halide in the exposed areas to metallic silver, producing an image by what is often termed the "chemical" development process. Simultaneously, however, the developer may act as a solvent, providing the solution with silver ions which can migrate to latent-image centers and there undergo reduction, by the "physical" development process. The extent to which this occurs has an important bearing on graininess in the developed image. From their studies on the role of solvent action by the developer, James and Vanselow have concluded that rate of solution is probably a more important factor than equilibrium solubility in ordinary photographic practice.¹

The fundamental information provided by equilibrium solubility data may be helpful in the interpretation of developer performance.

In addition to the reducing agent, a photographic developing solution may contain a variety of other ingredients which can increase or decrease the net solvent power, according to their relative concentrations. Thus, the water-solubility of silver bromide is first depressed, then elevated by the gradual addition of potassium bromide to the solvent, while the addition of sodium sulfite produces a marked and nearly linear rise in the solubility. Although solubility data have been reported previously in the literature for silver bromide in aqueous solutions of sulfite,²⁻⁶ excess bromide,⁶⁻¹⁰ thiocyanate,^{8,11} and ammonia and various amines,¹²⁻¹⁷ these data are incomplete, frequently conflicting, and impossible to correlate because of the diversity of temperatures at which the measurements were made. The only data available for more complex solvents which ap-

proximate typical developer compositions are those reported by Zyuskin¹⁸ for aqueous sulfite-carbonate-bromide-thiosulfate systems.

The values reported here apply to a few other systems of particular photographic interest. The solubility of silver bromide at 25°C has been studied as a function of thiocyanate concentration in water and also in a given carbonate-sulfite-bromide solution, of isopropylamine concentration in a similar medium, and of sulfite and bromide, simultaneously, in carbonate solution. Related data on the solubility of silver chloride in aqueous potassium oxalate solutions have been included, since none have been found in the literature.

In the present investigation, the influence of carbonate was found to be negligible by comparison with the other factors affecting the solubility of silver bromide. The effectiveness of solvents in which this component is varied, together with sulfite and bromide, at a given temperature, can therefore be described adequately by a simple, two-dimensional graph from which useful solubility predictions can be made. Such a correlation is given here for potassium bromide concentrations up to 10 grams per liter and sodium sulfite concentrations up to 80 grams per liter.

Experimental

Pure silver bromide was prepared in total darkness as follows: Ninety grams of silver nitrate were dissolved in 1 liter of warm distilled water and added slowly, with mechanical stirring, to a second warm solution containing 65 grams of potassium bromide in 1 liter. Stirring was continued for 1 hour. After a settling period of several hours, the silver bromide precipitate was washed by decantation and filtered on sintered glass. It was suspended in 1 liter of distilled water, stirred at least 30 minutes, and let settle for several hours. This washing procedure was repeated seven times. The precipitate was finally stored under distilled water in a brown-glass bottle. Portions used for solubility tests were removed by a small, glass dipper of 0.25-ml capacity.

Each sample was equilibrated with 100 ml of solvent in a wax-sealed volumetric flask. The solvents were prepared by combining and diluting measured volumes

* Communication No. 1801 from the Kodak Research Laboratories, Rochester 4, New York. Received 27 April, 1956.

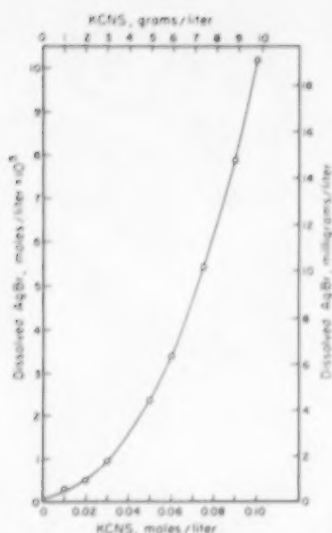


Fig. 1. Solubility of silver bromide at 25 C in aqueous potassium thiocyanate.

of fresh stock solutions of the reagent-grade chemicals. The flasks were attached to a wheel submerged in a constant-temperature water bath and rotated at the rate of 14 revolutions per minute, in subdued light. Mixing periods ranged from 7 to 24 hours, always exceeding the time required for attainment of equilibrium, as determined by preliminary experiments. The bath temperature was maintained at 25.0 ± 0.1 C for all determinations.

Aliquots of the saturated solutions were withdrawn by filter stick and pipet and digested with strong sulfuric acid to destroy soluble complexes and redissolve the silver halides. Finally, silver was determined by titration with standard potassium iodide solution to a potentiometric end point. The titrating solutions were standardized against known amounts of silver under the same conditions of concentration and pretreatment that applied to the samples taken for actual solubility determinations.

Details of procedure, which varied for the different solvents, are described below under separate headings.

1. Silver Bromide in Aqueous Potassium Thiocyanate

The solvent was prepared by dilution of a 0.1005 M potassium thiocyanate solution which had been stand-

ardized potentiometrically against N/10 silver nitrate. After equilibration, a 50 ml aliquot was treated with 10 ml of 15 M nitric acid and 1 ml of 18 M sulfuric acid, heating until heavy white fumes and the disappearance of precipitated silver bromide indicated that digestion was complete. The solution was then cooled, diluted, neutralized with ammonia, and reacidified with 0.5 ml excess of acetic acid, adding distilled water to bring the volume to 40 ml. The dissolved silver was determined by titration with 10^{-3} N potassium iodide solution. The results are given in Table I and Figure 1, where the solubility curve is extrapolated to the literature value of 8.8×10^{-2} M¹⁹ for silver bromide in pure water.

2. Silver Bromide in Aqueous Potassium Thiocyanate in the Presence of Carbonate, Sulfite, and Excess Bromide

The solvent was prepared from 0.404 M potassium thiocyanate solution and a filtered stock solution containing sodium carbonate, sodium sulfite, and potassium bromide, in such proportion that the diluted solvent in every case had a final concentration of 25.00 grams of sodium carbonate, 60.0 grams of sodium sulfite, and 7.30 grams of potassium bromide per liter.

After equilibration, a 5-ml sample of the solution was digested with 1 ml of nitric acid and 1.5 ml of sulfuric acid, with strong heating for some time after the appearance of SO_3 fumes. It was then cooled, neutralized with ammonia, and treated with acetic acid as in Section 1, and finally titrated with 1.034×10^{-3} M potassium iodide solution. Data from this series are given in Table II and Figure 2.

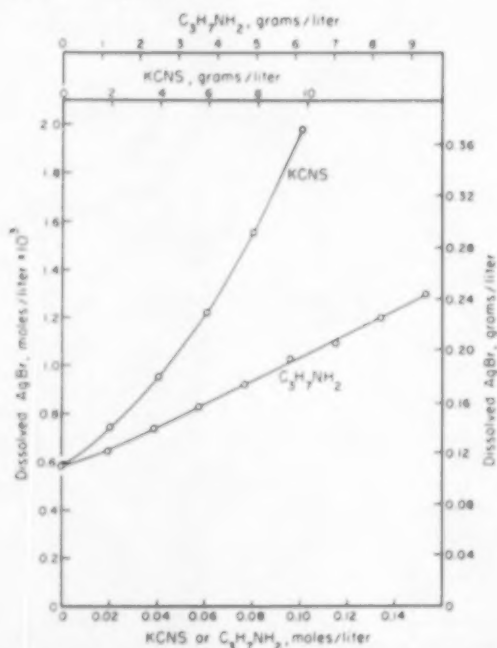


Figure 2. Solubility of silver bromide at 25 C in aqueous solutions containing (a) potassium thiocyanate and (b) isopropylamine, at fixed concentrations of sulfite, bromide, and carbonate. Both curves, 60.0 g/l. Na_2SO_3 , 7.30 g/l. KBr, 25.0 g/l. Na_2CO_3 .

Table I

SOLUBILITY OF AgBr IN AQUEOUS KCNS AT 25 C

KCNS		Dissolved AgBr	
M	g/l.	M	mg/l.
0.0100	0.97	0.31×10^{-3}	0.58
.0200	1.84	$.51 \times 10^{-3}$.96
.0301	2.93	$.95 \times 10^{-3}$	1.78
.0502	4.88	2.36×10^{-3}	4.43
.0603	5.86	3.39×10^{-3}	6.37
.0753	7.32	5.41×10^{-3}	10.16
.0903	8.77	7.87×10^{-3}	14.78
.1005	9.77	10.17×10^{-3}	19.10

Table II

SOLUBILITY OF AgBr IN AQUEOUS KCNS IN THE PRESENCE OF CARBONATE, SULFITE, AND EXCESS BROMIDE AT 25 C*

KCNS		Dissolved AgBr	
M	g/l.	M	g/l.
0	0.	0.586×10^{-2}	0.110
0.0202	1.96	746×10^{-2}	.140
0.0404	3.93	954×10^{-2}	.178
0.0607	5.90	1.222×10^{-2}	.230
0.0806	7.83	1.551×10^{-2}	.291
0.1010	9.81	1.979×10^{-2}	.372

* 25.0 g Na_2CO_3 , 60.0 g Na_2SO_3 , and 7.30 g KBr per liter; pH = 10.9 - 11.0

Measurements of pH on the equilibrated solutions from this and the following series of experiments were made with a line-operated Macbeth pH meter.

3. Silver Bromide in Aqueous Isopropylamine in the Presence of Carbonate, Sulfite, and Excess Bromide

Two stock solutions were used in preparing the solvent, one containing sodium carbonate, sodium sulfite, and potassium bromide in the same concentrations as in Section 2, and the other an approximately 0.4 M solution of isopropylamine. The latter was standardized by titration with N/10 hydrochloric acid just prior to use.

After equilibration, 5-ml aliquots of the saturated solutions were boiled to expel excess amine and analyzed for silver by the procedure outlined in the preceding section, using 3 ml of sulfuric acid for the digestion. Here,

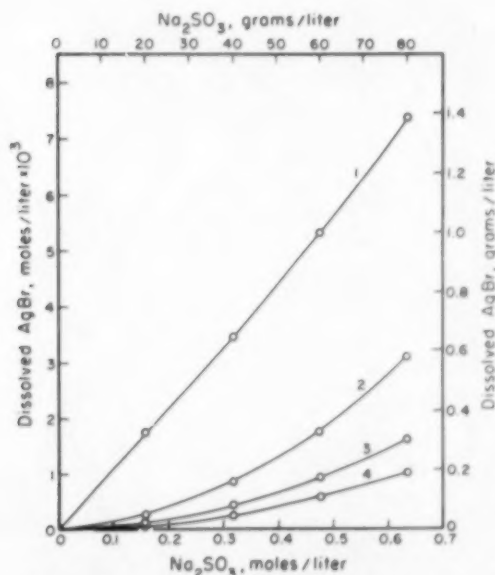


Figure 3. Solubility of silver bromide at 25 C in aqueous solutions containing sodium sulfite, at fixed concentrations of bromide and carbonate. All curves, 25.0 g/l. Na_2CO_3 . Curve 1, no KBr; Curve 2, 2.00 g/l. KBr; Curve 3, 5.00 g/l. KBr; Curve 4, 10.00 g/l. KBr.

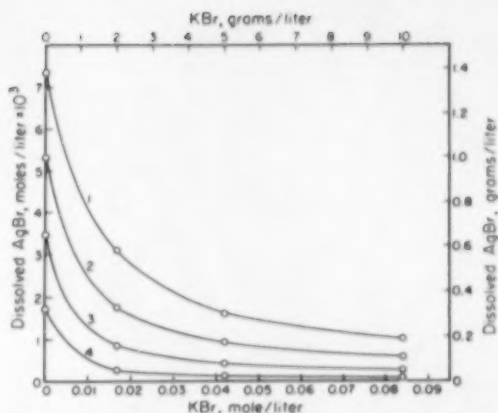


Figure 4. Solubility of silver bromide at 25 C in aqueous solutions containing potassium bromide, at fixed concentrations of sulfite and carbonate. All curves, 25.0 g/l. Na_2CO_3 . Curve 1, 80.0 g/l. Na_2SO_3 ; Curve 2, 60.0 g/l. Na_2SO_3 ; Curve 3, 40.0 g/l. Na_2SO_3 ; Curve 4, 20.0 g/l. Na_2SO_3 .

the titration standard was 6.95×10^{-4} N potassium iodide solution. The data are summarized in Table III and Figure 2.

4. Silver Bromide in Aqueous Sulfite-Bromide Mixtures in the Presence of Carbonate

To simulate alkaline developer conditions, sodium carbonate was added to the solvent in all but two determinations of this series, in which it was deliberately omitted in order to test the effect of pH on solubility in sulfite developers. The solvent was prepared by mixing a weighed amount of potassium bromide with an aliquot of strictly fresh stock solution containing sodium sulfite and sodium carbonate and diluting the mixtures to volume in the equilibration flask.

Samples taken for silver analysis varied in size according to the volume required for a feasible titration (about 5 ml). They were digested with 1-2 ml of nitric acid and 1.5 ml of sulfuric acid by the usual procedure, then diluted, neutralized, and reacidified as in Section 1. For the final titration, 4×10^{-3} N potassium iodide or its fourfold dilution was chosen according to the sample requirement.

Table III

SOLUBILITY OF AgBr IN AQUEOUS ISOPROPYLAMINE IN THE PRESENCE OF CARBONATE, SULFITE, AND EXCESS BROMIDE AT 25 C*

Amine		Dissolved AgBr	
M	g/l.	M	g/l.
0.0192	1.13	0.645×10^{-2}	0.1211
0.0384	2.27	740×10^{-2}	.1390
0.0575	3.40	833×10^{-2}	.1564
0.0765	4.52	923×10^{-2}	.1733
0.0958	5.66	1.024×10^{-2}	.1923
0.1150	6.80	1.092×10^{-2}	.2051
0.1342	7.93	1.200×10^{-2}	.2254
0.1530	9.04	1.299×10^{-2}	.2440

* 25.0 g Na_2CO_3 , 60.0 g Na_2SO_3 , and 7.30 g KBr per liter; pH = 11.3 - 11.7

Table IV

SOLUBILITY OF AgBr IN AQUEOUS Na_2SO_3 -KBr IN THE PRESENCE OF CARBONATE AT 25 C

M	KBr g/l.	Na_2SO_3 M	Na_2SO_3 g/l.	Dissolved AgBr M	Dissolved AgBr g/l.
0	0	0.1587	20.00	1.73×10^{-3}	0.326
0	0	.3174	40.00	3.46×10^{-3}	0.650
0	0	.4761	60.00	5.31×10^{-3}	0.997
0	0	.6349	80.00	7.36×10^{-3}	1.382
0.0168	2.000	.1587	20.00	0.281×10^{-3}	0.0528
.0168	2.000	.3174	40.00	0.858×10^{-3}	0.161*
.0168	2.000	.4761	60.00	1.76×10^{-3}	0.331
.0168	2.000	.6349	80.00	3.09×10^{-3}	0.580
.0420	5.000	.1587	20.00	0.117×10^{-3}	0.0220
.0420	5.000	.3174	40.00	0.407×10^{-3}	0.076
.0420	5.000	.4761	60.00	0.922×10^{-3}	0.173*
.0420	5.000	.6349	80.00	1.61×10^{-3}	0.302
.0840	10.000	.1587	20.00	0.087×10^{-3}	0.016
.0840	10.000	.3174	40.00	0.268×10^{-3}	0.503
.0840	10.000	.4761	60.00	0.573×10^{-3}	0.108
.0840	10.000	.6349	80.00	1.02×10^{-3}	0.192

* 25.00 g Na_2CO_3 per liter in all but these two.

The resulting solubility values, which are listed in Table IV, are shown in Figures 3 and 4, where the effects of varying sulfite and bromide concentrations are considered separately. By interpolation in these graphs, solvent compositions were found which correspond to equal silver bromide solubilities (Table V). This information was used to construct Figure 5, where each curve represents bromide and sulfite concentrations having equal (combined) solvent power with respect to silver bromide.

Table V

EQUIVALENT SOLVENTS FOR AgBr AT 25 C

Observed AgBr Solubility g/l.	Solvent Composition g/l.	Observed AgBr Solubility g/l.	Solvent Composition g/l.
	KBr Na_2SO_3		KBr Na_2SO_3
0.020	0 1.2	0.400	0 25.0
	2.00 8.0		0.57 40.0
	5.00 16.5		1.56 60.0
	6.7 20.0		2.00 67.2
	10.0 23.5		3.42 80.0
0.050	0 3.2	0.500	0 31.0
	2.00 15.0		0.30 40.0
	2.00 16.5		1.14 60.0
	5.00 31.5		2.00 74.2
	10.00 41.0		2.50 80.0
0.100	0 6.2	0.600	0 37.2
	1.10 20.0		0.09 40.0
	2.00 27.5		0.81 60.0
	3.60 40.0		1.88 80.0
	5.00 46.2		2.00 81.2
	10.00 59.5	0.700	0 43.3
	10.6 60.0		0.56 60.0
0.200	0 12.6	0.800	1.40 80.0
	0.40 20.0		0 49.1
	1.57 40.0		0.34 60.0
	2.00 45.0		1.06 80.0
	4.05 60.0	0.900	0 54.7
	5.00 64.8		0.16 60.0
	9.45 80.0		0.77 80.0
	10.0 81.0	1.00	0 60.2
0.300	0 18.8		0.54 80.0
	0.10 20.0		
	0.96 40.0		
	2.00 56.9		
	2.27 60.0		
	5.00 80.0		

5. Silver Chloride in Aqueous Potassium Oxalate

Silver chloride was precipitated by the slow addition of silver nitrate solution to a slight excess of hydrochloric acid, in the absence of light. The precipitate was washed repeatedly by decantation until free of chloride ion. It was kept under distilled water in a brown-glass bottle, and sampled as in the previous determinations with silver bromide.

The apparatus and general procedure were the same as those used with the silver bromide determinations. Freshly prepared solvent containing a weighed amount of potassium oxalate monohydrate was equilibrated for 24 hours with approximately 0.2 gram of the silver chloride in a sealed 100-ml flask, then aliquots were removed by pipet and filter stick for estimation of the dissolved silver. Sulfuric acid and hydrogen peroxide were used for the digestion step. Following the usual neutralization step, silver was determined by potentiometric titration with standard 2×10^{-4} N iodide solution. Each value in Table VI represents the average of three determinations, with a maximum range of about 5 percent. The solubility curve is given in Figure 6.

Discussion

In experiments corresponding to the higher thiocyanate concentrations in Table I, it appeared that the solid phase had been partially converted from AgBr (yellow) to AgCNS (white) in the equilibrium mixture. This was not true of experiments summarized in Table II, where all residues remained yellow. Since the literature¹⁹ records solubility values of the same order for AgBr (8.8×10^{-7} M) as for AgCNS (1.2×10^{-6} M) in water, it is reasonable to suppose that such changes

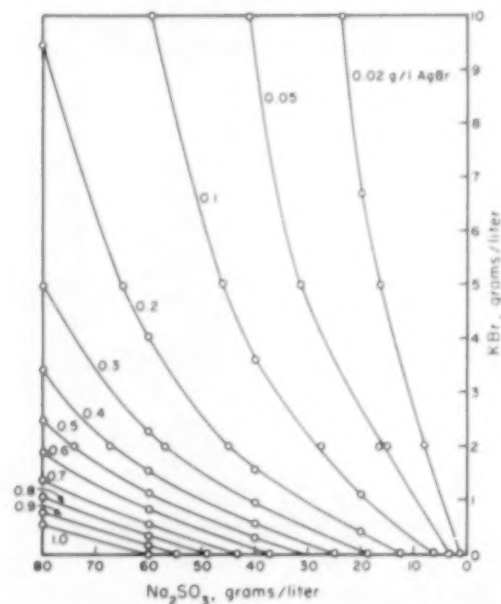


Figure 5. Equal-solubility curves for silver bromide at 25 C in aqueous solutions containing sodium sulfite and potassium bromide.

Table VI

SOLUBILITY OF AgCl IN AQUEOUS $\text{K}_2\text{C}_2\text{O}_4$ AT 25 C

$\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$		Dissolved AgCl	
M	g/l.	M	g/l.
0	0	1.22×10^{-3}	1.75×10^{-3}
0.326	60.0	3.89×10^{-3}	5.57×10^{-3}
0.651	120.0	5.46×10^{-3}	7.83×10^{-3}
1.303	240.0	8.48×10^{-3}	12.15×10^{-3}

would have little effect on the solubility curve. Actually, a smooth curve was obtained, with no evidence that variation in the amount of solid phase which was added originally had any effect on the agreement among replicates.

Each value recorded in Tables I-III represents the average of three determinations. An estimate of the average deviation for each series was obtained by comparing the deviations of individual results from the mean at each concentration level. In Table I, the average deviation was found to be 0.05×10^{-3} molarity units, and in Tables II and III, it was 0.005×10^{-3} molarity units.

Entries in Table IV each represent four determinations. Here, replicates showed an average deviation of less than 0.5 percent from the mean value at each concentration level for the solvent mixture. Entries in Table VI each represent three determinations, and the average deviation is about 2 percent of the mean. An average solubility value of 1.75 milligrams per liter was observed for silver chloride in distilled water. This compares with a value of 1.72 milligrams per liter, which was determined by Glowczynski²⁰ by the same general method. Other values reported in the literature obtained by other methods vary somewhat from this figure.

All data recorded in Table IV fit smooth solubility curves as shown in Figures 3 and 4, regardless of the presence or absence of carbonate. To confirm the observation that carbonate has no appreciable effect on the solubility of silver bromide in sulfite-bromide developer solutions, two additional determinations were made under conditions duplicating two listed in Table IV, except that carbonate was now omitted from the solvent. For a solvent composition of 40.0 grams of sodium sulfite and 10.00 grams of potassium bromide per liter, the solubility value obtained was 0.275×10^{-3} M, compared with 0.268×10^{-3} when 25 grams of sodium carbonate per liter was also present. For a solvent composition of 80 grams of sodium sulfite and 2.00 grams of potassium bromide per liter, the value obtained was 3.09×10^{-3} M, agreeing perfectly with that obtained in the presence of carbonate.

The arrangement of data in the form of equal-solubility curves (Figure 5) summarizes our present information for sulfite-bromide-carbonate systems at 25 C. Since carbonate has been demonstrated to have a negligible influence, the solubility of silver bromide is shown as a function of only two variables, the concentrations of

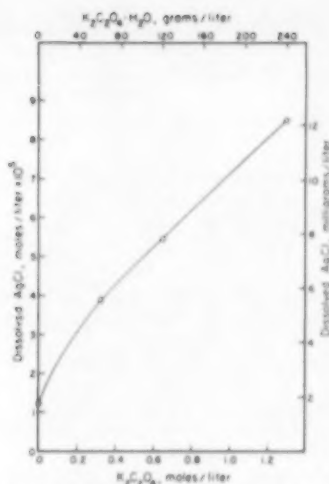


Figure 6. Solubility of silver chloride at 25 C in aqueous potassium oxalate.

sulfite and of bromide. By interpolation in Figure 5, reasonably accurate predictions of the solubility of silver bromide can be made for any aqueous solvent containing simultaneously 0-80 grams of sodium sulfite, 0-10 grams of potassium bromide, and 0-25 grams of sodium carbonate per liter.

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PSA TECHNICAL PAPER AWARD FOR 1955

J. I. Crabtree*

THE PSA TECHNICAL PAPER AWARD for 1955, given to the author or authors of the best technical article appearing in any official publication of the Society during each calendar year, was bestowed upon T. Howard James for the paper "Dependence of the Rate of Development of Surface Latent Image on the Temperature of the Developer" published in the May 1955 issue of PHOTOGRAPHIC SCIENCE AND TECHNIQUE. Dr. James is a Research Associate in the Kodak Research Laboratories, Rochester, N. Y. The citation read on the occasion of the presentation of the Award at the Color Processing Conference held at the Hotel Seneca, Rochester, N. Y., May 25-26, 1956 is appended.

The inter-division award committee, working under the sponsorship of the Technical Division, awarded an Honorable Mention to John O. Brostrup, Asst. Chief, Photography Division, Medical Illustration Service, Armed Forces Institute of Pathology, Washington, D. C., for the runner-up paper in the committee voting entitled "Simultaneous Multiple Dye Transfer Color Printing," published in the February 1955 issue of PHOTOGRAPHIC SCIENCE AND TECHNIQUE. The awards committee consisted of H. H. Duerr and C. B. Neblette, representing the Technical Division; L. B. Dunnigan, representing the Stereo Division; W. K. Raxworthy, representing the Color Division; H. B. Tuttle, representing the Motion Picture Division; and Chairman John I. Crabtree, of the Technical Division.

Formerly known as the *Journal Award*, this formal recognition of the outstanding technical paper published in each calendar year was instituted in 1949. Following are the respective authors honored in years past:

- 1949—J. I. Crabtree, FPSA: "Rapid Processing of Films and Papers" PSA Journal Vol. 15, pp. 130-136, Feb. 1949.
- 1950—F. B. Noel, FPSA and P. B. Davis: "New Low-Voltage Low-Power Flashtube of High Efficiency" PSA Journal Vol. 16B (PS&T), pp. 11-16, Jan. 1950.
- 1951—L. A. Jones, Hon. FPSA: "Psychophysical Evaluation of Quality of Photographic Reproductions" PSA Journal Vol. 17, pp. 751-764, Dec. 1951.
- 1952—R. W. Henn, FPSA: "Properties of Developing Agents II. Paraminophenols" PSA Journal Vol. 18B (PS&T), pp. 90-95, Oct. 1952.
- 1953—F. V. Chu, R. W. Nottorf, and W. H. Vinton: "Swelling Characteristics of Synthetic Polymer Emulsions Under Processing Conditions" PSA Journal Vol. 19B (PS&T) pp. 43-47, May 1953.
- 1954—Lester Horwitz: "Mechanisms of Color Sensitization" PSA Journal Vol. 1 (PS&T) pp. 43-51, May 1954.

The regulations governing the Technical Paper Awards Committee appear on page 9 of the Administrative Practices for the Technical Division of the Photographic Society of America, approved by the PSA Board of Directors October 6, 1954, and are as follows:

Sec. 2.: (b) 1. The TECHNICAL PAPER AWARDS COMMITTEE shall consist of a Chairman, two members appointed by the Technical Awards Committee Chairman, subject to approval by the TD Chairman

*Chairman, Technical Paper Awards Committee, PSA Technical Division.

and by the TD Executive Committee, and one representative from each of the following Divisions other than TD who wish to participate: Color, Motion Picture, Nature and Stereo.

2. *Duties:* Its duties shall be to recommend to the TD Executive Committee the author or authors of the best technical paper published in the PSA Journal, Photographic Science and Technique or any other official PSA publication, to receive the Division's Annual Technical Paper Award.

3. *Award:* The PSA-TD Technical Paper Award shall be made on the basis of the following qualifications:

(a) The paper shall have been published originally in any official PSA publication, during the preceding year.

(b) The paper must deal with some scientific or technical aspect in the field of photography.

(c) In judging the merits of the paper, three qualities shall be considered as follows:

- 1. Technical merit and importance of material..... 45%
- 2. Originality and breadth of interest..... 35%
- 3. Excellence of presentation of material..... 20%

A majority vote of the entire Committee shall be required for the election of the Award. Absent members may vote in writing. The report of the Committee shall be presented to the TD Executive Committee before March 1st of the succeeding year. At the annual meeting of the PSA a suitably embellished certificate shall be presented to the author, or to each of the authors, of the most outstanding paper.

4. *Honorable Mention:* Other papers may be cited for Honorable Mention at the option of the Committee, but in any case shall not exceed three in number.

5. *Publication:* These regulations, a list of all Technical Paper Award recipients, the year of each award, and the title of the papers, shall be published at least annually in the PSA Journal. In addition, the list of papers selected for Honorable Mention shall be published during the year current with the award.

Citation on Thomas Howard James

Thomas Howard James was born in Denver, Colorado, in 1912. He received his B.A. degree from the University of Colorado in 1932 and his Ph.D. degree, also from the University of Colorado, in 1935. He served as an assistant in chemistry over the years 1931-35 and as an instructor in chemistry at the University during the academic year 1935-36. Dr. James joined the Research Laboratories of the Eastman Kodak Company in 1936 and has continued this association from that date.



Dr. T. Howard James

Dr. James' research at Kodak has been almost exclusively concerned with the fundamental theory of the photographic process, particularly in the field of latent-image development. He has published a total of ninety papers in this field, almost all of which present the results

PHOTOGRAPHIC SCIENCE AND TECHNIQUE

of investigations which he has carried on alone or in collaboration with others. He has written articles on photography in "Thorpe's Dictionary of Pure and Applied Chemistry" and in the "Encyclopedia of Chemical Technology" and has contributed several chapters to "The Theory of the Photographic Process," by Mees. The book which Dr. James wrote with Dr. G. C. Higgins, "Fundamentals of Photographic Theory," is considered one of the classics in this field.

Dr. James is a member of the Photographic Society of America, the Society of Photographic Engineers, the Royal Photographic Society, the New York Academy of Sciences, and Phi Beta Kappa, honorary scholastic fraternity. He is also a member of Sigma Xi, honorary scientific society; he was president of the Rochester Chapter in 1953-54. Dr. James is currently president of the Rochester Council of Scientific Societies.

Dr. James' contributions to photographic theory have

been recognized by several awards. He was presented the Henderson Medal of the Royal Photographic Society in 1945 and the Davanne Medal of the Société Française de Photographie for 1952.

Dr. James is editor of the photographic section of *Chemical Abstracts* and associate editor of *Photographic Science and Technique*. He is on the Technical Advisory Board of *Photographic Engineering*.

Dr. James' scientific investigations over the past twenty years have contributed greatly to our understanding of the mechanism of development of the photographic latent image. His work on the kinetics of development and on adsorption processes in development and his interpretation of his observations in terms of a coherent theory of development have placed Dr. James among the foremost authorities in the world in this field. His contributions to other phases of latent-image formation and behavior have also been significant.

AN ALUM-ORGANIC WASH TANK SLUDGE*

K. R. Hughes, R. W. Henn, and J. I. Crabtree

ABSTRACT

The presence of scum on processed films, produced by suspended matter in the wash tanks, is probably the most widespread of current physical defects inconveniencing the photographer. The sludge is formed when the alum from the fixing bath is precipitated by dilution of the fixer in the wash tank, and the aluminum hydroxide is then flocculated, by the organic matter present, into cohesive particles. The presence of both alum and organic matter appears to be essential to its formation.

The difficulty is more pronounced the higher the organic content of the wash water, the slower the rate of flow, and the lower the agitation. It is common to most alum fixing baths but is most prevalent when the alum content and pH values are high, and when no borate is present. It is minimized by a rapid, turbulent flow of water, by the addition of boric or citric acid to the fixer, and by dripping acid into the wash tank. Periodic draining of the tank to remove accumulated sludge is particularly effective.

WORKERS in almost every branch of photography have encountered, at some time or other, a gelatinous sludge in their wash tanks which adheres stubbornly to films or papers with which it comes in contact. The adhering sludge is not removed by further washing and clings as a spotty scum to the surface of the dried film or print.

The scum appears on film in the form of irregularly shaped, discrete spots varying from a fraction of a millimeter to several millimeters in diameter, and may be light-colored or quite strongly brown, depending on the presence of coloring matter in the wash water.

The most serious epidemics of sludge formation are apt to occur in the later summer or early fall when reservoirs are low and organic growth is at its height. In fact, the sludge has been incorrectly attributed to the accumulation of matter from an impure water supply, or growths of organisms within the tank itself. However, these are not in themselves the cause of the sludge. Actually, a precipitate of aluminum hydroxide is formed

when fixing baths containing an aluminum compound are carried over and diluted in the wash tanks. In the presence of even small amounts of organic matter, such

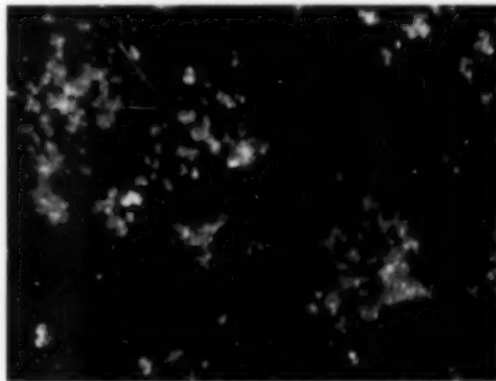


Fig. 1. Alum-organic specks on negative, viewed by reflected light, 100 \times magnification

*Communication No. 1797 from the Kodak Research Laboratories, Rochester 4, N. Y. Received 30 April, 1956.

Table I

COMPOSITION OF SLUDGE FORMED IN DIFFERENT WATER SAMPLES

Water Sample	(Kodak Rapid Liquid Fixer, 1:3) Dilution, 1:100 Sludge Weight	% Aluminum
Distilled water	0.35 grams	6.6
Tap Water No. 1 (rapid sand filtration)	0.97 grams	4.4
Tap Water No. 2 (no filtration)	1.60 grams	3.6

as bacteria or algae, the precipitate flocculates into amorphous masses which settle out or adhere to surfaces such as the walls of the tank or the films being washed. The name "alum-organic" sludge would seem appropriate since both components, namely, the aluminum and the organic matter, are equally important in its formation.

Previous studies have been made of the nature and methods of prevention of various scums and sludges in photography,^{1,2} and this particular type of sludge has been reported on briefly.³ Much information on alum flocculation is available in the technology of water purification, since alum is routinely added to some water supplies to aid in the removal, by flocculation, of objectionable micro-organisms.⁴ The present paper, however, gives more detailed information on the factors affecting the formation of this alum-organic sludge in photography and suggests methods of preventing the difficulties arising from its accumulation.

Nature of the Alum-Organic Sludge

Analysis

Microscopically, the scum and sludge specks appear to be composed of large numbers of very fine particles, bound together in white or brownish masses (Figure 1). They are partially soluble in strong acids and bases, and yield strong, positive, qualitative tests for aluminum.⁵ Frequently iron is incorporated as rust particles or ferric hydroxide, and accounts for some of the color. Algae contain chlorophyll which tends to color the sludge yellow or light green.

In order to determine the proportion of aluminum in a given amount of sludge, 100-ml portions of the alum hardening fixing bath (Kodak Rapid Liquid Fixer) were

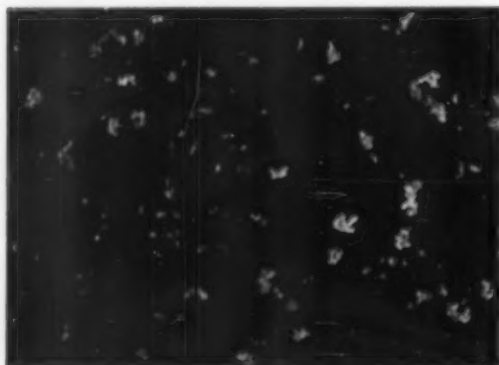


Fig. 2a. Aluminum hydroxide precipitated in distilled water, dark-field illumination, 1000 \times magnification.

Table II

EFFECT OF WATER SUPPLY ON QUANTITY OF SLUDGE
(With Kodak Rapid Liquid Fixer, 1:3)

Fixer Dilution	Distilled Water	Tap Water No. 1	Tap Water No. 2	Pond Water	Algae Culture
1:4	—	—	—	—	—
1:8	+	+	++++	—	—
1:16	+++	+++	++++	+	+++
1:32	+++	+++	++++	++++	++++
1:64	+++	+++	++++	++++	++++
1:128	++	++	+	++++	++++
1:256	+	+	+	++++	+
1:512	—	—	*	+	+
1:1024	—	—	—	+	—

+ Indicates a just-visible precipitate.
 +++ } Indicate increasing precipitation.
 +++++ }
 — Indicates no visible precipitate under the conditions of the test.
 * Indicates possible, but uncertain, precipitation.

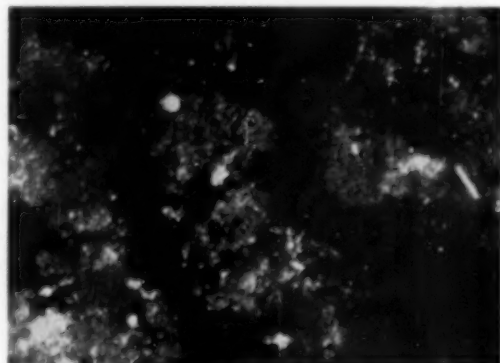


Fig. 2b. Aluminum hydroxide precipitated in tap water and allowed to flocculate. The white circles and the rodlike structure are discrete cells of organic matter and are surrounded by finer particles of flocculated organic matter and aluminum hydroxide. Dark-field illumination, 1000 \times magnification.

added to 10-liter samples of water representing differing levels of contamination. On standing, flocculent precipitates formed which were removed by filtration, air-dried, and the aluminum components determined. It is seen from Table I that the aluminum content varies from 3.6 to 6.6%, the percent aluminum in the sludge decreasing with increasing organic matter. Both the total quantity of sludge formed and the proportion of organic matter in it will increase with increasing quantity of organic matter in the water supply.

It is interesting to compare these analyses of laboratory-produced sludges with an analysis of a sludge encountered in an x-ray wash tank. This was a stringy, cohesive, white sludge, partly soluble in dilute hydrochloric acid, leaving a mesh of interlaced hyphae. A volume of 1 cc (approximately 1000 mg) dried to yield 78 mg of residue, which, on ignition, gave 42 mg of ash. A total of 18 mg of this ash was found to comprise aluminum. The sludge contained a little sulfite and about 1.3% of its weight could be calculated as sulfur dioxide. It would appear, therefore, that the bulk of this sludge consisted of organic matter, whereas alumi-

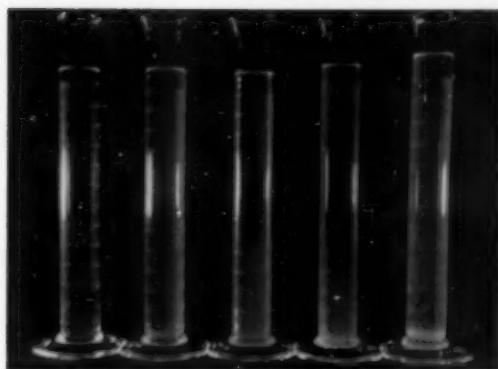


Fig. 5. Effect of organic matter concentration on rate of flocculation of the aluminum hydroxide (24 hrs.).

Left to Right: Cylinder 1—Distilled water.
Cylinder 2—Distilled water + Kodak Rapid Liquid Fixer (1:250).
Cylinder 3—Filtered tap water + Kodak Rapid Liquid Fixer (1:250).
Cylinder 4—Unfiltered tap water + Kodak Rapid Liquid Fixer (1:150).
Cylinder 5—Water from open pond + Kodak Rapid Liquid Fixer (1:250).

num hydroxide accounts for a large part of the weight of the dried sludge, and aluminum oxide for most of the weight of the ash. Some basic aluminum sulfite was also evidently present.

Manner of Sludge Formation

Formation of the sludge involves two distinct steps: (a) precipitation of aluminum hydroxide, and (b) formation of a coagulum or "floc."

In the absence of strong acids, bases, or sequestering agents, aluminum ions react with water to form aluminum hydroxide.



If an alum hardening fixing bath is diluted with distilled water, the precipitate formed is very fine, as shown in Figure 2a. However, in the presence of micro-organisms or organic matter, as when the fixer is diluted with tap water, the individual particles are seen to be grouped into cohesive gelatinous masses (see Figure 2b) similar to those seen adhering to negatives.

Several factors affect the rate of formation and the quantity of the precipitate. The influence of the amount of organic matter in the water supply is indicated in Table II and Figure 3, in which a 0.04% concentration of the fixer was added to various water supplies. The floc will form at any normal pH value of the wash water (see Table III), but it can be avoided by adding acid to the water, as will be discussed later. The rate of floc formation also increases slightly with increase in temperature. Agitation is an important factor and will also be discussed later.

Formation of the precipitate is common to alum-containing fixers (Table IV) and to a plain alum solution but is absent with non-alum fixers (F-24). The quantity of precipitate increases with increasing alum content of the fixer, while the tendency to precipitate decreases as the degree of acidity of the fixer increases (pH value

Table III

EFFECT OF pH OF WATER ON SLUDGE FORMATION
(Kodak Rapid Liquid Fixer, 1:3. Dilution, 1:250)

pH*	Amount of Sludge
4.0	—
4.5	±
5.0	+
5.5	++
6.0	+++
6.5	++++
7.0	+++++
7.5	+++++
8.0	+++++
8.5	+++++
9.0	++
9.5	+
10.0	±
10.5	±
11.0	—

* The pH of the diluted aqueous solution of fixing bath was adjusted to these values.

± Indicates a just-visible precipitate.

++ Indicates increasing precipitation.

+++ Indicates increasing precipitation.

++++ Indicates no visible precipitate under the conditions of the test.

± Indicates possible, but uncertain, precipitation.

decreases, Table V). Citric acid is a very effective addend in preventing precipitation since it ties the alum into an un-ionized complex but it also reduces its hardening action (Table VI). Boric acid has a much less deleterious effect on the hardening, and is capable of some reduction of the sludging propensity. The complete absence of boric acid, as in Fixer F-1, greatly increases the propensity to sludge. The effect of acetic acid is probably mostly to increase the total acidity.

Nature of the Organic Contamination

The source of the troublesome organisms is ordinarily the water supply, and there is wide variation in the number of organisms observed from one locale to another, depending on the method of water purification used. There is also a seasonal variation due to the heavier growth of aquatic life and greater water demand in late summer. Sometimes work on a pipeline will stir up otherwise dormant organisms. Growth of algae within the tank itself is thought to be negligible, since chemical and lighting conditions are not sufficiently favorable for their proliferation in keeping with the rate at which sludge forms in practice. However, sometimes mold slimes add to the mass of the sludge. The algicide preparations on the market require drainage of the tanks which, in itself, is frequently a sufficient remedy.

The actual amount of organic matter necessary to aid in floc formation is low. Water from a municipal supply can support the growth of a floc and still be considered good drinking water. In addition, the type of organic matter is not very important. In various tests, grossly contaminated samples of water from an open pond, mixed cultures of algae, and pure cultures of several types of bacteria all supported floc formation, even when diluted up to 1:100 with distilled water. Samples taken from two different water supplies (Tap Water No. 1 and No. 2 of Table II) during August and February likewise supported floc formation, while some floc appeared on the

Table IV

COMPARISON OF SLUDGING TENDENCIES OF DIFFERENT FIXERS ON DILUTION

Fixer	pH	Quantity of Sludge at Dilution of									
		1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048
Kodak F-5	4.3	—	—	+	++	+++	++	++	+	+	—
Kodak F-6	5.0	++	+++	++++	++++	++++	++	++	+	+	—
Kodak Rapid Liquid Fixer	4.5	—	+	++	+++	+++	+++	++	++	+	—
Kodak F-1	4.3	—	+	++	++++	+++	+++	++	++	+	—
Kodak F-24	4.8	—	—	—	—	—	—	—	—	—	—
2% Potassium Alum	..	—	+	+++	+++	++	++	++	++	+	—

Table V

EFFECT OF pH AND HARDENER CONTENT (KODAK RAPID LIQUID FIXER, 1:3)

Fixer	pH	Quantity of Sludge at Dilution of									
		1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048
Control (unmodified)	4.5	—	+	++	+++	+++	+++	++	++	+	—
pH reduced	4.0	—	—	—	—	+	++	++	++	++	—
pH raised	5.0	—	++	+++	+++	+++	+++	++	++	+	—
1/2 Hardener Conc.	4.5	—	—	—	+	++	++	++	+	+	—
2X Hardener Conc.	4.5	—	+	+++	++++	++++	++++	+++	++	+	—

+ Indicates a just-visible precipitate.
 ++ }
 +++ } Indicate increasing precipitation.
 ++++ }
 — Indicates no visible precipitate under the conditions of the test.

Table VI

EFFECT OF ACID ADDITION TO KODAK RAPID LIQUID FIXER, 1:3

Agent	Conc. (Grams per Liter)	pH	Melting Point* (° F.)	Precipitation in Tap Water No. 2 at Dilutions of		
				1:20	1:100	1:500
Control	0	4.50	212+	++	++++	++
Citric acid	1	4.47	212+	+	++++	+
	2	4.42	190	+	+++	+
	4	4.40	150	—	+++	—
	8	4.18	100	—	—	—
Boric acid	2	4.50	212+	+	+++	++
	4	4.50	212+	+	+++	+
	8	4.50	212+	—	++	+
	16	4.46	212+	—	+	—
Acetic acid	10	4.38	180	—	++	+
	20	4.20	130	—	+	+

* Kodak Matrix Film, fixed 5 minutes in the modified fixing bath.

+ Indicates a just-visible precipitate.

++ }
+++ } Indicate increasing precipitation.
++++ }

— Indicates no visible precipitate under the conditions of the test.

surface of film suspended in distilled water. Inorganic pigments, such as rust scale, fine sand, and diatomaceous earth, do not seem to affect the flocculation rate, but add to the over-all quantity of sludge formed.

Practical Tank Tests

The Pako Senior Filmachine was taken as an example of a processing machine in widespread use among photo-finishers. The operating load of this machine is commonly 300 films per hour and the carry-over rate is about 3 gal. per 1000 films. This represents about 60 ml of fixer carried over each minute into a 120-gal. wash tank

having a water flow of about 6 gal. per minute. In an attempt to reproduce these conditions on a smaller scale, tanks of 8-gal. capacity were set up with variable wash-water and fixer inputs. A relatively well filtered water supply was used, along with Kodak Rapid Liquid Fixer (1:3). A 2-liters-per-minute water flow and a 2-ml-per-minute fixer input were employed as being somewhat more favorable than the actual conditions. The following are the results of some of the tests conducted with these tanks:

1. The rate of sludge formation was observed with a water flow of 2 liters per minute and a fixer input of 2 ml per minute. After 10 minutes, a distinct turbidity

could be seen in the bath, but no flocculation. During a 4-hr period, the turbidity increased and became more granular, but a definite floc had not formed. Increasing the carry-over rate increased the turbidity but did not cause floc formation.

2. With the fixer input maintained at the rate of 2 ml per minute, the effects of different water flow rates were observed. At a rate of 1 liter per minute, the turbidity built up rapidly and some flocculation took place, with a few larger masses of sludge forming and settling to the bottom. At rates higher than normal (4 to 8 liters per minute), the turbidity level remained much lower and no flocculation occurred.

3. After a definite degree of turbidity had been reached in a tank, the fixer input was cut off and observations were made on the rate at which the wash water cleaned out the bath. At the rate of 2 liters per minute, the theoretical complete tank volume replacement time was 16 minutes, but at the end of this period the bath was still markedly turbid, with the sludge continuing to be removed slowly. Water flow rates as high as 8 liters per minute were required to clean out most of the sludge within this period.

4. When both the water and the fixer flows were stopped, leaving a turbid bath with no agitation, flocculation occurred. During a 2-hr period, the masses of sludge could be seen growing in size and gradually settling out. After standing overnight, most of the sludge had settled in a loose layer several inches deep on the bottom of the tank, the remainder adhering to the tank walls and floating on the surface as a scum. Some individual masses of sludge were as large as 1 cm in length. On resuming the flow of water, the material was stirred up into the bath, where it slowly circulated with the water currents. Removal with the water overflow was not as efficient as in the case of the unflocculated precipitate.

5. Several methods of local agitation were tried in order to prevent flocculation. Recirculation of the water with an external pump and air agitation (in this case with a flow of 0.5 standard cubic feet per minute through small orifices in a coil) were both successful. Markedly turbid baths would not flocculate while the agitation continued, but when agitation was stopped, the flocs formed as just described. Violent agitation rendered the precipitate unable to flocculate, even on prolonged standing.

Discussion

With a knowledge of the actual nature of the alum-organic sludge, as well as of the experiences with actual tanks, the problem can be divided into discussions of factors affecting (a) the formation and (b) the accumulation of the sludge, and (c) its adherence to film.

Factors Affecting Sludge Formation

The amount of precipitate which forms is dependent on the type of fixer used, the carry-over rate, and the pH value in the wash tanks. In general, the more acid fixers with low-alum and high-sequestering agent concentrations will produce less sludge. Reducing the carry-over rate will cut down on the sludge formed, and maintaining the pH of the wash water below 4.5 will prevent precipitation of the hydroxide altogether.

The rate at which the precipitate flocculates is mainly

determined by the quantity of organic matter and the amount of agitation. In many cases, the water supply is sufficiently pure that moderate water flow rates will prevent flocculation. Ordinarily, a rate which would allow complete tank volume replacement in 5 to 10 minutes would be sufficient to (a) prevent excessive turbidity in the bath, and (b) prevent flocculation during use. Mixing within the tanks should be such that there are no backwashes and little or no agitation. Ideally, the water supplies are free from organic matter to the extent that the amount of sludge which accumulates in one or several days' time is not objectionable. In some cases, however, as during the worst seasons of the year, special control measures may be necessary.

Factors Affecting the Accumulation of Sludge

The amount of sludge which accumulates in the wash tanks is of great practical importance, since this determines how much is likely to be carried away on the films. Although the precipitate is finely divided, even a small amount will cause the bath to appear slightly turbid, but this is not troublesome, since the suspension is quite efficiently removed with the outgoing wash water. If any precipitate adheres to the film, it is unnoticeable. However, when the bath becomes quite turbid, enough precipitate is carried out on the film to dry down as a very thin coating, resembling the residue left after film has been washed with very hard water. If a wetting-agent bath follows the wash, alum sludge may accumulate and flocculate there, requiring frequent changing.

The greatest difficulty is caused by the flocculated sludge, because when this accumulates, masses large enough to be seen with the naked eye begin to adhere to the films being processed. Removal of the floc with outgoing wash water is not efficient, since it tends to settle and adhere to surfaces. The factor most affecting the accumulation of this flocculated sludge is the amount of time the machine remains idle without drainage of the wash tanks, since, during this period, the entire amount of precipitate in the bath has a chance to form a floc and settle out. Even with very good water supplies, on resuming operation of the machine, this coagulated sludge is lifted into circulation and, provided there is no drainage of the tank, the state of the bath becomes progressively worse from day to day, until sludge appears on the negatives.

In a particular test, the wash tanks of a Pako Senior Filmachine were drained routinely every weekend. No difficulty was encountered, until, for purposes of this study, the weekend draining was omitted. On the twelfth day after the last draining, sludge had accumulated to the extent that it was visible on the films being processed. A sample strip was examined and seen to be covered with typical specks of alum-organic sludge. Since the water supply of these tanks was relatively well filtered, it is probable that with some other sources, trouble would have been encountered sooner.

Factors Affecting the Adherence of the Sludge to Films

With a given amount of sludge in a bath, several factors influence the amount which will be carried out on the films. Of these, withdrawal rate is the most important. Films withdrawn from a contaminated bath

in a fraction of a second tend to carry away a minimum of sludge, whereas withdrawal protracted over a period of 30 to 60 seconds, as in some commercial machines, causes much sludge to be drawn toward and out with the film.

Surface-active agents lower the degree of adherence somewhat but offer only a partial remedy. Water jets directed at the film surface as it leaves the bath will remove much of the adhering sludge, but must be used on both surfaces. Air squeegees can be used to create a turbulence at the surface of the water, having the same effect as the water jets. However, air jets positioned away from the water surface seem to anchor the sludge more firmly in place as the excess water is blown away. Before drying, the unwanted matter can be removed by sponging, as with wet cotton or a cellulose sponge.

Prevention of Difficulties Caused by Wash-Tank Sludge

A general understanding of the source of the alum-organic type sludge will, in most cases, be adequate to prevent it from becoming a source of trouble. Wash tanks should be inspected frequently while in actual operation to determine how turbid the water is and how much organized floc has formed. The beam of a flashlight is useful for this, since the fine particles of the precipitate scatter light. At the end of a working day, the tank should be drained if much sludge is present but, in most cases, weekly drainage will keep the sludge below an objectionable level; however, inspection may show that a more frequent drainage is necessary. When the tanks are not drained, the surface should be skimmed and the bath stirred thoroughly, as with the other processing solutions, before starting up the machine.

If careful maintenance does not prevent sludging, or if frequent drainage is not practical, as in machines in continuous use, some of the following additional measures can be taken:

1. The type of fixer is usually restricted by the equipment used. However, if a choice is available, as in hand processing, the most suitable fixer can be adopted. Kodak F-5 represents an alum hardening fixer with a minimum tendency to sludge because of its low pH value and its boric acid content. The use of a nonhardening fixing bath, such as Kodak F-24, will, of course, effectively prevent scum formation, but this type of fixer must be used with caution since the lack of hardening will retard the drying, and the resultant increased swelling introduces danger of abrasion and reticulation.

2. As much as 2 grams of citric acid can be added per liter of Kodak Rapid Liquid Fixer, 1:3 ($\frac{1}{4}$ ounce per gallon) without entirely destroying its hardening properties, as shown in Table V. This serves to reduce the precipitation of the hydroxide and inhibit its tendency to flocculate. Alternately, as much as 16 grams per liter of boric acid (about 2 ounces per gallon) can be used, without interfering with the hardening properties.

3. If two fixing baths are used, the hardener can be omitted from the second bath, thus cutting down on the alum carried into the wash.

4. The addition of an extra stop bath after the fixer has proved useful in a test installation. Kodak SB-1a was used both to rinse off as much alum as possible and to keep the pH value down.

5. Any measures designed to decrease the alum carry-over into the wash tank will be useful. Air squeegees and wringer rollers are effective, and prolonged draining or hand squeegeeing may be practical if high production rates are not required.

6. Maintaining as high a water flow rate as possible will tend to prevent the accumulation of sludge. Frequently, the flow can be kept at normal levels for long periods, and then increased only when inspection shows that the bath has started to become turbid.

7. In areas where the water supply contains much organic matter, water filters may afford some relief. Canton flannel bags tied over water outlets will screen out larger masses, but commercial filters are more effective. However, when these start to become clogged, they must be changed before they cut down too much on the water flow.

8. Attempts have been made to drip acetic or citric acid solutions into the wash water in order to acidify the bath and minimize hydroxide precipitation. Theoretically, about 1 ml of glacial acetic acid per gallon of wash water would be sufficient to keep the pH below 4.5, but in actual practice some disadvantages are encountered. Mixing in the bath is not perfect, so that larger amounts of the acid are necessary. Also, washing is not as efficient at the lower pH values,⁶ while citric acid, at a concentration of 0.2 to 0.4%, will tend to soften previously hardened films.

9. The introduction of Kodak Photo-Flo into the wash tanks at a rate of about 1 ml per minute (for 6-gallons-per-minute water flow) reduces the propensity of the floc to adhere to the film.

10. The use of water jets, applied to both surfaces of the film as it leaves the wash tank, can be recommended.

11. Where possible, rapid removal of the film from the wash tank will cause it to carry away a minimum of sludge.

Removal of Scum

The alum-organic sludge adhering to dried negatives can ordinarily be effectively removed by swabbing with a 5% solution of sodium carbonate. This solution will, however, cause some swelling, and, if the negative has not been fixed in a bath having good hardening properties, it is best first to harden the negative in the Kodak Formalin Hardener SH-1 and then to bathe it in 2% hydrochloric acid.² This treatment will usually remove the scum, although the formalin in the hardener tends to harden the organic matter of the scum as well as the gelatin and make its removal more difficult.

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PROCESSING REQUIREMENTS OF ANSCOCHROME TYPE PRINTON FILM

Carl E. Johnson*

ABSTRACT

The basic processing requirements are discussed following alternative methods; with replenishment and without. Compatibility of the film in existing Printon solutions and compatibility of the present film in new Printon solutions are discussed. Data are given on agitation, contamination, exhaustion, temperature tolerance, and process control.

IN THE LATTER PART of 1956, a new Anscochrome Type Printon Film will be released. This new product has been designed to yield improved photographic results.¹ Compared to the existing Printon Film, the processing requirements are equally simple but somewhat modified. For the first time since the original introduction of Printon Film,² simultaneous changes have been made in the product and in the processing formulas, although both have been improved through the years. When Printon Film was introduced in 1945, it employed a developing agent³ which irritated the skin of certain sensitive individuals. In 1948, Printon processing was converted to use the nonirritating developing agent S-54. In later years, the bleach formulation was altered to minimize stain, and the fixing bath was modified to improve the stability of the dyes during storage of the film. Dozens of color finishers have successfully employed Printon Film for their color printing operations. However, the new Anscochrome Type Printon Film gives even greater uniformity of processing as well as an improved final color print. The new processing formulas have in particular, improved solution life and process consistency. These advantages of course, are of utmost importance in maintaining a profitable color printing business.

Processing of the new Anscochrome Type Printon Film is designed to be carried out in either of two ways. The first method is adapted to the needs of the small finisher, the advanced amateur, or the professional photographer. It calls for the use of a single set of solutions for their full life, and then discarding them without any attempt at replenishment. Used in this fashion, the new Printon processing formulas give consistent results throughout the processing of eighty five 8 × 10 inch prints or equivalent, per 3½ gallon tank without objectionable changes in the processing characteristics. This processing capacity of the solutions designed for the new Anscochrome Type Printon Film is greater than that obtained with the older Printon solutions, and the photographic variations occurring over this exhaustion route have been reduced.

The second recommended method of using the new Anscochrome Type Printon solutions is to extend their life and capacity with replenishment. The replenishment method is designed for the larger color photofinishers. By using a factory packaged replenishing kit,

the processing capacity of all solutions can be extended six times up to a total of over five hundred 8 × 10 prints or equivalent in a 3½ gallon size tank, or three thousand 8 × 10 prints per 20 gallon size tank. At this point, it is recommended that the tanks be emptied, cleaned, and filled with fresh solution before continuing the operation.

This periodic cleaning and changing of the solution tanks is a practice prevalent in black and white photofinishing, a far less critical process. It is considered an excellent precautionary measure to prevent wide drifting of color balance due to improper or prolonged use of continuously replenished solutions. From an economical view point the use of replenishers is recommended since chemical costs will be cut in half. This replenishment end point may be extended successfully in very large scale operations with large volumes of solution where control chemists are employed using analytical techniques. However, these conditions apply to only a few photofinishing installations, and must be handled on an individual basis.

The Basic Process

The basic process as outlined in Table I has the same number of steps that is used in processing the present Ansco Color Printon Film. The first developer converts the exposed silver halide grain into a negative silver image. After the short stop and rinse to remove the first developer chemicals, a second exposure to light, followed by subsequent color development, forms

Table I

ANSCOCHROME TYPE PRINTON PROCESS

Solution	Time	Temperature
First Developer	10' ± 15"	75F ± 1/2°F
Short Stop	2'	70F - 75F
Wash	5'	70F - 75F
Second Exposure	30 Seconds Each Side to #2 Photo Flood in a Reflector at a Dist. of 3 Ft.	
Color Developer	10' ± 30"	75F ± 1F
Short Stop	1'	70F - 75F
Hardener	3'	70F - 75F
Wash	5'	70F - 75F
Bleach	5'	70F - 75F
Wash	5'	70F - 75F
Fixer	4'	70F - 75F
Final Wash	10'	70F - 75F
Anti Spot Stabilizing Bath	2'	70F - 75F
Dry		

* Development Department, Ansco Division of General Aniline and Film Corporation, Binghamton, New York. Presented at the Color Processing Conference in Rochester, New York May 26, 1956, sponsored by the Technical Division of the PSA. Received 12 June 1956.

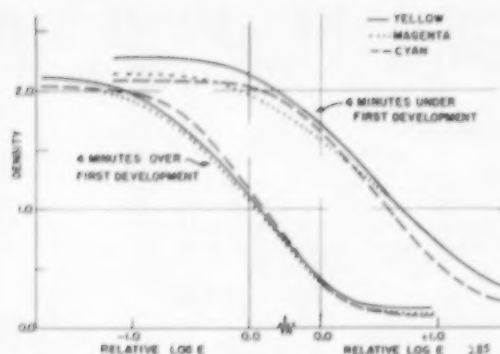


Fig. 1. Effect on Anscochrome Type Printon film of varying time of first development. Underdevelopment reduces the effective speed and produces pink highlights. Overdevelopment steepens the toe gradation and lowers the maximum density. Note that two sets of characteristic curves have been combined but displaced laterally.

positive dye images simultaneously in each of the three layers.

After the second short stop the Anscochrome Type Printon Film is hardened and then washed to remove remaining color developer chemicals. In the bleach bath, all first and color developed silver is converted into silver salts soluble in hypo. After a short wash, these salts, along with undeveloped silver halides, are fixed out. After final washing the Anscochrome Type Printon Film is given a short rinse in an anti water spot stabilizing bath. The Printon Film is then dried with any conventional color film drying technique.

The major changes in the processing procedure for the new Printon Film lie in the two development steps. Both the new first developer formula, #503, and the new color developer formula, #655, represent radical changes of composition tailored expressly for Anscochrome Type Printon Film. The new first developer has been modified to give improved exhaustion capacity and oxidation stability, and part of the improvement shown by the new product with respect to lower stain and longer scale of gradation was obtained by means of the change in the color developer formula.

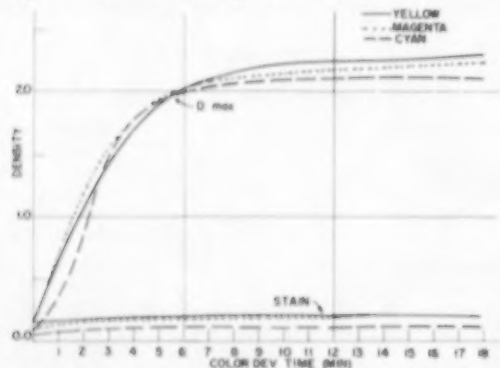


Fig. 2. Variations in the time of color development of the new Anscochrome Type Printon film have little effect when prolonged beyond the optimum processing time.

The first developer is the most critical solution in the process. The time of first development should not be allowed to vary more than plus or minus 15 seconds, and the temperature should be held to within $\pm 1/2$ F. In addition, agitation rates should be constant and reproducible in the first developer. Under development at this stage will result in pink highlights and slower speeds. Excessive first development will produce a steeper toe with cleaner highlights and increased speed, but lower D-Max. (See Figure 1).

The color developer, on the other hand, is not as critical as the first developer with respect to time, temperature, and agitation variations. Unlike the former Ansco Color Printon color developer, the new color developer reaches a development plateau after the necessary reaction time. Prolonged color development beyond this optimum time will not alter the Anscochrome Type Printon Film characteristic curve to any significant extent (See Figure 2).

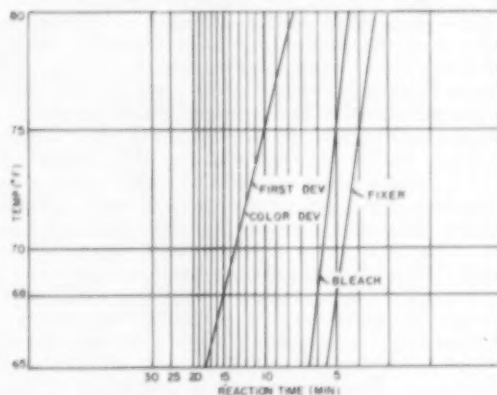


Fig. 3. Time-temperature chart for first developer, color developer, fixer, and bleach showing the processing time adjustments required when solution temperatures vary from the American Standard Processing Temperature at 68F.

Time and Temperature Tolerances

The process has been designed for 75F processing and best results will be obtained at that temperature. However, lower temperatures with higher compensating reaction times will give satisfactory results. Figure 3 represents the Time vs. Temperature chart for first and color developers, the bleach, and fixing bath.

Exhaustion and Replenishment Data

As mentioned earlier, the new Anscochrome Type Printon Film is designed to be processed in either of two ways. The first method, of interest to the small finisher, is to use a single set of solutions for their full life without any attempt to replenish them. When used in this manner a finisher can process up to eighty five 8 X 10 prints per 3 1/2 gallon kit without serious loss of quality, if the solutions are not more than one week old.

Regardless of how many Anscochrome Type Printon Films have been processed, when the kit solutions are one

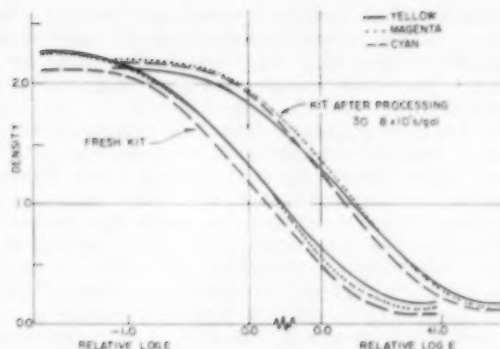


Fig. 4. Effect of exhaustion of Anscochrome Type Printon chemicals in a system used without replenishment.

week old they should be discarded. Figure 4 illustrates how an exhausted kit will produce slightly steeper overall highlight gradation, and a reduction in yellow shoulder gradation in comparison with a fresh kit. The degree of exhaustion shown in the illustration is approximately 25% more than the recommended exhaustion. The quality of the Anscochrome Type Printon Film at this point would not be considered acceptable.

The second method which will probably appeal to most photofinishers, is to replenish the Anscochrome Type Printon processing solutions and thereby extend their capacity and life. With replenishment the keeping properties of the solutions are extended to three weeks, and processing capacity is increased to at least 3 thousand 8×10 prints per 20 gallon tank (See Figure 5). Regardless of whether or not the processing solutions are replenished floating lids should be kept on developer tanks when they are not in use to minimize the adverse effects of aerial oxidation. The replenishment rates for all solutions are tabulated in Table II.

Agitation

Time and temperature have been shown to play important roles in the proper functioning of the first

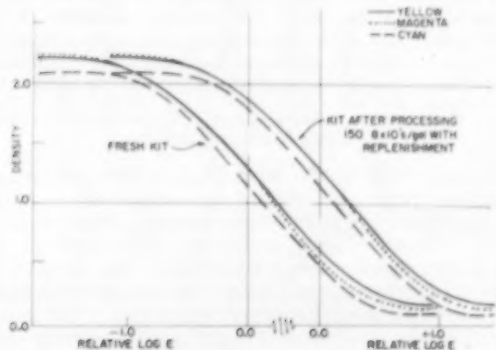


Fig. 5. Effect of exhaustion in a replenished system of Anscochrome Type Printon chemicals following the directions of the manufacturer.

Table II

REPLENISHMENT RATES FOR ANSCOCROME TYPE PRINTER PROCESSING SOLUTIONS

Solution	Rate of Replenishment/80 in ²
First Developer	40 cc
Short Stop	20 cc
Color Developer	40 cc
Short Stop	20 cc
Bleach	20 cc
Fixer	20 cc
Stabilizing Bath	20 cc

developer. As can be expected, the rate of agitation is also an important factor. The times in Table I are based on a standardized manual agitation technique; one which gives minimum streaking and is easily reproduced.

Manual agitation, commonly used in color finishing laboratories, consists of sharply tapping the hangers two or three times to dislodge any air bells clinging to the emulsion surface after the film enters each solution. Once each minute thereafter the hangers are lifted from the solution and tilted nearly 90 degrees. After a short

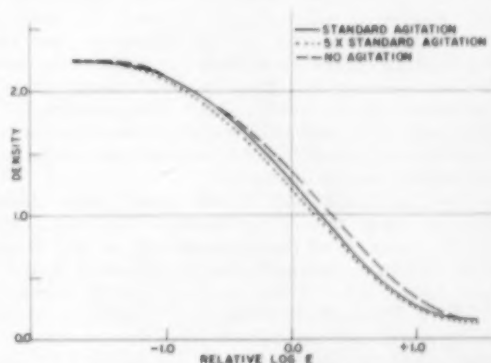


Fig. 6. Effect of departures from normal agitation during first development on the visual density of Anscochrome Type Printon film.

one or two second pause in mid air, the hangers are reimmersed in the solution and the draining cycle is repeated tilting them in the opposite direction. The entire cycle should be completed in 7 to 9 seconds.

There are many techniques of agitation in use today by the different color film processors. Vane agitation, gaseous bursts, solution impingement, and manual agitation are all in use in various plants. These differences in agitation techniques among the photofinishers result in variations in rate of development. As can be seen in Figure 6, the rate of agitation in the first developer is particularly critical at the lower level, and it may be necessary for some operators using automatic equipment to change their first development time to best suit the type of agitation they are using. It should be again emphasized that after time, temperature, and agitation rates have been standardized they should not be allowed to vary, particularly in the case of the first developer.

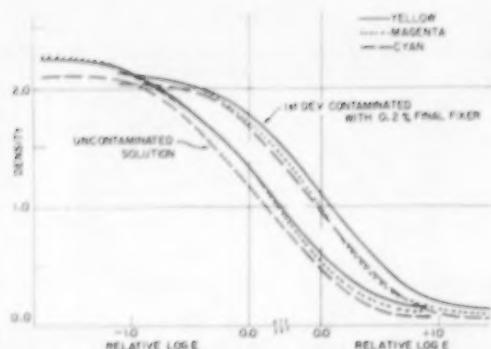


Fig. 7. Ansochrome Type Printon first developer solution contaminated with 0.2% fixing bath shifts the color balance toward the green, increases the effective speed of the Printon Film, and lowers the maximum density.

Washing and Contamination

An important factor in obtaining good processing quality with Ansochrome Type Printon Film, as well as most other photographic products, is the copious use of water. Plenty of water should be used not only to provide efficient washing during processing, but also during cleaning operations to flush down tank sides, tank covers, film hangers, and other apparatus where processing solutions may have splashed. Hangers should be drained well when transferring them between solutions and the operator should be very careful not to carry or drip one solution into another.

Solution contamination is the cause, often unsuspected, of much processing trouble. Few processors realize the pronounced photographic effects which may result from what seems to be minor contamination.

Hypo carried into the first developer, by splashing or by dried crystals clinging to improperly washed developing hangers will shift the color balance toward the green, increase speed, and lower Dmax. (See Figure 7). Only small amounts are necessary, for as little as 1 ml. of fixer per liter of developer gives noticeable changes.

Contamination of color developer by first developer may result from splashing or from insufficiently washing

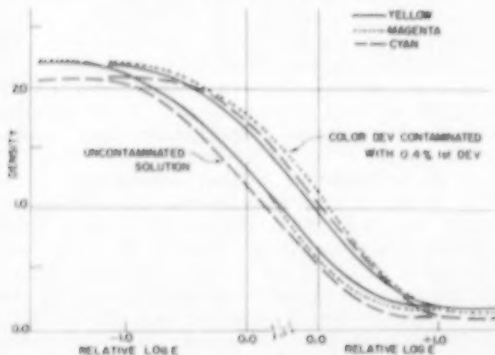


Fig. 8. Color developer contaminated with 0.4% of first developer solution affects the color balance of the Printon pictures.

Printon films and hangers between first and color developer. It too, becomes noticeable at a concentration range of 1 ml per liter, and usually is evidenced by a loss in yellow color balance, and some magenta color balance loss relative to the cyan (Figure 8).

The Ansochrome Type Printon Film processing formulas have been designed specifically for the new Ansochrome Type Printon material. Ansco Color Printon Film can be processed in the new solutions and will yield lower stain, but steeper cyan and yellow gradation (Figure 9). The new Printon material can be processed by the old processing procedure with passable results although the whites will be somewhat stained (Figure 10). Ansochrome camera film when processed in the Ansochrome Printon solutions will be softer in overall gradation, and have a low, greenish, Dmax. (See Figure 11). It is planned that the present Ansco Duplicating Films, Type 638 and 538, will be replaced by an Ansochrome type material processable in the Printon film outfits.

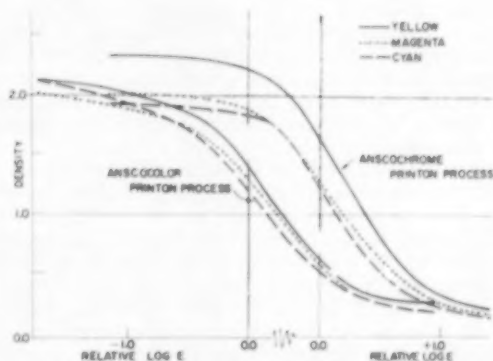


Fig. 9. Present Printon Film, when processed in chemicals designed for the new Ansochrome Type Printon Film, has steeper cyan and yellow gradation and lower stain.

It should be emphasized that ideal results with the new Ansochrome Type Printon Film developers will be obtained only when Ansochrome Type Printon Film exclusively is processed therein. Color photofinishers, who are now using universal processing lines will need to install separate tanks for the Ansochrome Type Printon first and color developers. All other solutions may still be used in common for Ansochrome camera films, Printon material, and color duplicating films.

Process Control

A closer look at the new Printon Film processing procedure shows that the solution temperatures, wash water temperature, and solution keeping properties have smaller tolerances than previously recommended. At first glance this appears to contradict the features of increased developer capacities and satisfactory processing tolerances exhibited by the new process. More strict control of physical factors is intentionally recommended, although the new process is as tolerant as the former Ansco Color Printon processing routine with respect to most physical and chemical factors.

The original Printon processing procedure was designed in the 1940's when processing control techniques were in their infancy and when both finishers and the public were less quality conscious. Getting out color prints was the big problem and small refinements in control and quality were less appreciated than today.

The 1956 Photofinishing Industry is entering a new era. The color finishers realize they need and they expect to use process control. They want variations reduced to a minimum in their day to day processing. It is considered the responsibility of the manufacturer to provide the proper recommendations to get the utmost from his products. Even though Anscochrome Type Printon Film is no more critical than Ansco Color Printon Film, experience has shown that best results will be obtained when the product is consistently processed within the tolerances recommended in Table I.

Whichever method is used, whether batch or continuous processing, some measures of sensitometric process control are needed. Most large operations will employ statistical control charts. Smaller processing laboratories which do not wish to invest in a color densitometer will rely on visual, comparative methods. Both methods have been found satisfactory when properly employed and the size of the processing operation usually is the main factor in deciding which technique to use.

It is expected that before the end of 1956 complete processing control information, including control charts, control strips, and test transparencies, will be made available to Anscochrome Type Printon Film finishers.

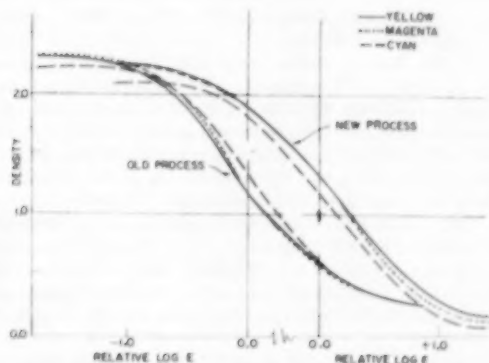


Fig. 10. The new Anscochrome Type Printon Film, when processed in chemicals designed for the present type Printon material, produces passable results except for higher stain. As a result the use of the correct processing chemicals is recommended.

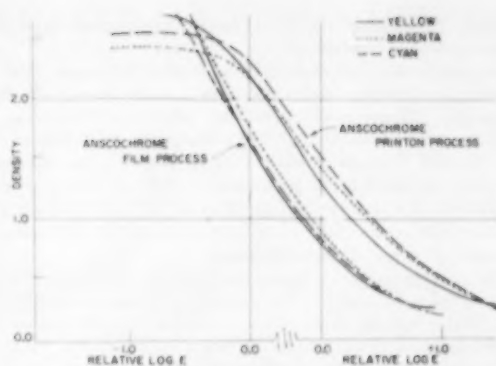


Fig. 11. Anscochrome high speed color film for use in cameras when processed in solutions designed for the Printon Film is softer in over all gradation and has a low greenish Dmax. The use of the correct solutions is strongly recommended.

Until that time the color finisher would be wise to print a test transparency along with a grey wedge for a visual, comparative method of process control.

Summary

Printon Film and its processing procedures have been improved in the past 11 years culminating in Anscochrome Type Printon Film. Although the new process is similar in basic processing steps to Ansco Color Printon Film and tolerant of most physical and chemical factors, more strict controls are recommended in order to enable the color finisher to keep a consistently high level of quality and reduce makeovers to a very low level.

Acknowledgments

The author wishes to express appreciation to Messrs. W. Bischof, L. G. Welliver, and C. M. Whittemore, of these Laboratories for their contributions of data, and to Mr. J. E. Bates for his guidance and helpful criticism.

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BOOKS RECEIVED

PHOTOGRAPHIE ET CINÉMATOGRAPHIE ULTRA-RAPIDES, Actes du 2ème Congrès International, Paris, September 1954. Published by DUNOD, 92 Rue Bonaparte (6^e), Paris, 1956. 6,000 francs.

The Proceedings of the second international high-speed symposium are now available in this large volume (454 pages, 8 1/4 x 11 1/2 inches) prepared by Pierre Naslin and Jean Vivie.

The lavishly illustrated volume (some are in natural color) contains 68 technical papers grouped under the following 14 headings: (1) Flash lamps and flash cameras, (2) Radiography, (3) High-speed shutters, (4) Mechanical-optical cameras, (5) Image-dissection cameras, (6) Sensitive surfaces, (7) Lighting, (8) Applications in several fields, (9) Ballistics, (10) Shock and failure processes, (11) Schlieren and interferometry, (12)

Biology, (13) Metallurgy and mechanical engineering, (14) Automization of fluid sprays.

The papers are published in their original language, French, English, or German, with summaries in every case in all three languages. Thirty-two papers were written in French, 21 in English, and 15 in German. The translations of the summaries into English from original French or German are excellent, which is no small accomplishment in technical writing, particularly in the photographic field where no good glossaries of international terms exist. Captions under all the illustrations likewise are given in three languages.

The volume has been painstakingly edited by Pierre Naslin, who served as Secretary of the organizing committee, and by M. Jean Vivie, permanent secretary of l'Association Française des Ingénieurs et Techniciens du Cinéma, which was the organization that sponsored the Symposium. It belongs in every library which possesses the five earlier booklets on "High Speed Photography" published by the SMPTE. Until the Proceedings of the Third Congress (London, September 1956) become available, this work constitutes the most complete and up-to-date collection of literature on the subject of high speed photography and cinematography. P.A.

HOW TO FIND A BUYER FOR YOUR INVENTION, F. D. Angerman, Science and Mechanics Publishing Company, 450 East Ohio Street, Chicago 11, Illinois. 1956. 186 pages. \$2.95.

This is described as a brand-new authoritative guide which tells the individual inventor how, when, and where to find a buyer for his invention. Written by the Editor and Publisher of *Science and Mechanics* magazine, the primary purpose is to provide a list of manufacturers who are actively and currently interested in buying new inventions. The firms listed are indexed four ways; according to type of invention wanted, according to raw materials with which the firm is prepared to work, according to the manufacturing processes and equipment available, and according to the facilities they can extend to the inventor.

The book offers many valuable suggestions on selling inventions, discusses the functions of patent brokers, the questions of patentability, patent procedure, and procedures for disclosing ideas to others. This guidance material occupies 136 pages in the first part of the book.

Manufacturers throughout the country who cooperate with the publishers are granted a free listing in the book and some 140 of them are to be found in the first edition, including many well-known names in American industry. P.A.

KNOW YOUR CAMERA, Alfred Wagg. Wilfred Funk, Inc., 153 East 24th Street, New York 10, N. Y. June, 1946. 244 pages. \$3.95.

"This book is designed to do for the modern photographer what the modern cook book does for the cook. The beginner desperately needs the cook book and the experienced cook enjoys finding new recipes." In this manner Mr. Wagg intends to convey that his book is designed for both the rank amateur and the professional. Unfortunately, he fulfills neither promise. He does, however, very nicely fulfill an unavowed phase of photographic explanation.

According to the introduction by Bob Considine, the noted sports writer, the book is intended to be a non technical volume for the average person confused by the simple box camera. It is supposed to stimulate the reader's interest and point the way to more rewarding photographs, whether the novice aspires to be an artist or a family documentarian.

The early chapters which concern "Shopping for the Camera," "Learning About Lenses" and "Accessories as Tools" are the most confusing. These chapters contain merely parades of many different models, classified and described, but with no effort toward directing the amateur toward making a choice based on his interests, needs, or purse. This cataloging might prove somewhat interesting to another professional to reveal the opinions of one of his compatriots. The terms of focus, aperture and shutter speeds are neatly disposed of in five brief paragraphs.

Once Mr. Wagg assumes his reader has a full knowledge of the mechanics of photography, he does a very admirable job presenting his views on picture composition, use of filters and what any good photographer should look for in considering subject material. Here Mr. Wagg shows that he is a fine photographer with a great sense of pride in his craft and a sensitive feeling for what makes a good photograph. The reader is led almost to believe that the trade secrets are being revealed in these chapters.

The book is not to be recommended for novices or professionals. It is best suited for those who have had a reasonable amount of experience with the mechanics of photography who desire to improve the quality of their pictures by the manner in which they utilize their subjects. R.S.

EXPOSURE WITH THE ZONE SYSTEM. Minor White, Morgan and Morgan, Publishers, New York. 1956. 40 pages with paper cover. \$1.25.

In an introduction, written by Beaumont Newhall, an associate of the author at Eastman House in Rochester, New York, it is explained that Mr. White found the Zone System ideal for the purpose of helping students to acquire "the solid technique which is the very basis of creative work in photography."

Instructions are given for constructing a gray scale of 10 steps to be fastened on to a photoelectric exposure meter. If the reader owns a Weston Master exposure meter, he will be pleased to find a ready-made gray scale on page 3 all ready to be cut out and pasted on his calculator dial. The meter, thus equipped, can be calibrated in terms of a film-development-print combination selected by the photographer as carefully explained by Mr. White.

The subtitle of the book reads: "How to get correct exposure for your photographs every time." The studious photographer, equipped with an exposure meter of the photoelectric type, who is experimentally inclined and has aspirations in the field of creative photography should find this little volume of great interest. P.A.

MICRORECORDING, Industrial and Library Applications. Chester M. Lewis and William H. Offenhauser, Jr. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1956. 468 pages, \$8.50. To be reviewed in the November issue.

AMERICAN STANDARDS FOR COLOR FINISHERS

R. J. Wilkinson*

ABSTRACT

Voluntary standards developed under the national program provide nationally accepted specifications for chemicals used in color processing. The dimensions of color slides, including stereo, and other conditions of viewing and projecting color pictures are set by common agreement.

ON THE THRESHOLD of a new business venture, we do not need to be reminded, as business men, that there is no substitute for technical knowledge. With that in mind, I want to speak to you about a subject which can have tremendous impact on the economic side of the color finishing business.

Color finishers in some countries of the world must be prepared to mount stereo slides in three different sizes. In the United States only one size is recognized.

Why should color finishers in America be so fortunate? The answer to that question is not hard to find. The photofinisher is saved from headaches, delays, costly blunders and unnecessary duplication of effort by the existence of some 300 American Standards in the field of photography and motion pictures.

Since 1939 engineers, scientists, technicians and photographic experts of various sorts have worked together to establish these standards. The photographic manufacturers, the dealers and distributors of photographic supplies and equipment, representatives of the military and other government departments, and consumers' organizations have supported this work. The agency which has brought them together in this common purpose is the American Standards Association, commonly known by its initials, ASA.

American standards are a form of national approval which guarantee that a consensus in favor of the standard has been affirmatively expressed by all groups having a substantial interest in the subject. The committees which develop American Standards must do more than work out a technically competent document based on sound engineering principles. In addition, they must enlist in the work of drafting the standards of all groups who wish to participate. Before seeking approval by the American Standards Association, the committee must bring the subject to the attention of others known to have a substantial interest in the matter for comment. All objections must be dealt with before approval as an American Standard can be given.

I have the honor to serve on one of the Committees responsible for the approval of American Standards in the field of photography. I represent both consumer interests and distributor interests on the Photographic Standards Board as the delegate of the Master Photo Dealers' and Finishers' Association.

The Photographic Standards Board is an administrative committee responsible for the work of six technical committees. One of these committees develops standards for motion pictures and television. Another is

concerned with photographic reproduction of documents, the problems involving microfilming, microcards, diazotype prints, blue prints and other photo copies.

The other four committees deal with the fundamentals of photography and with the sensitized materials, the equipment and the processing chemicals and techniques of special interest to all photographers but especially the color finishers.

As I remarked before, about 300 American Standards have already been developed in the field of photography. Many of these are of a fundamental nature, having to do with film speed and exposure indexes, with the calibration of densitometers, the determination of resolving power of a lens or the standard temperature for processing. Others establish the specifications of commodities for photographic use. We have a large group of standards for "Photographic Grade" chemicals which have become the standard of both the photographic industry and the chemical industry as well. Another important group of standards is concerned with the dimensions which insure proper fit and interchangeability of equipment items, sometimes of different manufacture.

The four standards committees working on fundamental problems in photography and their 20-odd subcommittees and task groups are still active. American Standards must be kept current and it is necessary to review them periodically and make changes wherever necessary to keep them up to date.

New standards are constantly being developed as the need arises. When confronted with an exasperating problem, most of us are inclined to say: "There ought to be a law requiring everybody to do this or that." American Standards are not the law and there is no enforcement behind them other than the power of common sense that tells us to *get in step*.

The American Standards program, however, provides a means to *do something* about recurring problems. It even provides the possibility of "doing something" before a problem arises, or before it grows too big to do anything about it. This is accomplished by setting up standards to guide future developments; by pointing out the best way for those who follow.

Anyone can request an American Standard. I am amazed over and over again whenever I see that one group, one organization, even a single individual, by a simple request can command the attention and services of so many experts. A technical committee representing the entire photographic industry, large and small firms, government departments, consumer organizations, dealer organizations, college professors, and others can be put to work on *your* problem simply by writing a letter to the headquarters of the American Standards Association outlining the problem and, if possible, suggesting the nature of a desirable solution.

* Master Photo Dealers' & Finishers' Association, 104 E. Michigan Avenue, Jackson, Michigan. Presented at the Color Processing Conference sponsored by the PSA Technical Division in Rochester, New York, 25 May 1956. Received 11 May 1956.

The sort of cooperation within the photographic world itself which makes American Standards for photography possible is exemplified by a slogan which for many years has guided the work of the ASA committees, "If it is good for photography, it is good for everybody in photography." This pretty well identifies the spirit in which voluntary standards are developed under the democratic procedures of the ASA. If you want to learn more about photographic standards, write to the American Standards Association at 70 East Forty-fifth Street, New York 17, New York. One of the staff members will be glad to answer your questions and to show you how American Standards can help your business and safeguard your profits.

I wish each of you every success in your business of color processing and related activities.

DENSITOMETERS AND DENSITOMETRY

A symposium on densitometers and densitometry was held 28 April, 1956 at the Imperial College of Science and Technology, South Kensington, England with Mr. E. M. H. Selwyn as Chairman. The following summary has been supplied through the kindness of Mr. R. E. Withrington, Hon. Sec. of the Scientific and Technical Group of the Royal Photographic Society of Great Britain.

R. J. Hercock of Ilford Limited spoke on "An Automatic Densitometer," describing a new model of the early photoelectric densitometer discussed by Toy and Rawling of the British Photographic Research Association in 1924. Shortcomings of the earlier model have been corrected in the new one. In the latter, the measuring wedge and the unknown density are in the same beam of light, which is split by a rotating mirror. The amplifier is ac instead of dc to avoid drift of the galvanometer spot. The measuring wedge is controlled by a motor responding to the photocell to eliminate human errors in estimating the balance point.

"A Densitometer for Color Print Materials" was described by P. B. Watt of Kodak Limited, capable of reading reflection densities up to 3 with an accuracy of 0.01 for densities below 1, an accuracy of 0.02 for densities from 1 to 2, and an accuracy of 0.1 for densities greater than 2. Drift is not greater than 0.01 in half an hour.

D. M. Neale of Ilford Limited presented a paper "Balance-Indication and Density Range Extension in a Split Beam Densitometer Using Low Frequency Beam Chopping." Asked why he had used such a slow chopping speed (7 c/s), instead of a circuit using photomultipliers, Mr. Neale replied that he had designed this method as an alternative to that on which his colleagues were working.

E. A. Harvey, also of Ilford Limited, described "A Method of Driving a Chopping Disc at Slow or Moderate Speeds," which dealt with mechanical problems in Mr. Neale's densitometer.

"A Simplified Treatment of the Relation between Diffuse and Specular Density" was contributed by P. G. Powell of Kodak Limited. The assumption was made that silver grains in a photographic layer behave as perfectly absorbing obstacles, so that simple diffraction theory would be applicable.

G. Syke of Baldwin Instrument Company presented a paper written in collaboration with S. L. Fulton, "Densitometers and Densitometry" which dealt with the subject from the viewpoint of the professional instrument designer.

The meeting concluded with an inspection and demonstration of a number of different densitometers, including those discussed by Hercock, Neale, and Watt, and additional instruments loaned by several companies.

CONTAINER FOR 35MM FILMSTRIP

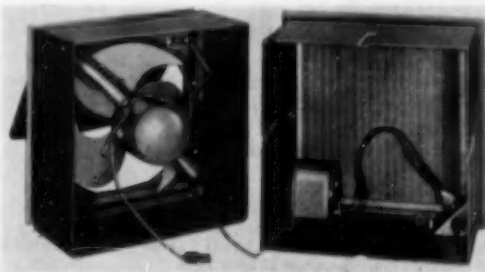
Richards Manufacturing Co., of 5914 Noble Ave., Van Nuys, California offer a lightweight, unbreakable, moisture proof plastic container for 35mm filmstrip or other storage purpose with attached lid. The containers have been ingeniously moulded from *one piece* of polyethylene with interior dimensions $1\frac{3}{8} \times 1\frac{3}{8}$ inches and the exterior sized to fit existing storage containers. Called Poly-Cons, the containers are available in several colors from the manufacturers.



Ilg Electric Ventilating Company, Chicago, has developed a new silent, light-proof, darkroom ventilator equipped with deadlight louver which allows free circulation of fresh air while providing positive protection against unwanted light.

The ventilator may be installed in outside walls or inside room partitions. The illustration shows the model designed for outside walls. A spring tight outside door, which automatically opens when the fan is turned on, protects against the weather. The inside partition type ventilator is the same except that it has no weather protection door or door motor as shown in the right portion of the picture.

The noise-free, vibrationless, balanced fan wheel is directly connected to the motor. It has an air moving capacity of 260 cubic feet per minute. The deadlight louver is easily removed to provide access to the fan. In tests, 7000 ft. candles directed against the open side of the fan caused light penetration of only 0.004 Lamberts.



PHOTOGRAPHIC SCIENCE AND TECHNIQUE